YOUR T.V. WEATHER MAP

'WHEN THE ELEMENTS CONSPIRE'

Damage at Chapel Point, Lincolnshire, on the night of 31st January, 1953. *See also fig. 1, page 8.*

Photograph by W. North

YOUR T.V. WEATHER MAP

BY

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INTRODUCTION

DURING the War of 1939–45 many of us noticed the weather for the first time! Up to then the weather had been, at various times, a nuisance or a joke or a pleasant surprise according to the extent to which it disturbed our everyday life. Any idea, however, that we could anticipate tomorrow's weather and plan our day accordingly was too fantastic for words! Didn't the B.B.C. issue forecasts which were notoriously wrong or at least were so unhelpful as to promise us 'fair conditions generally but locally showery with risk of hail and thunder'? Then the War came and the weather forecast became an official secret to be shared, probably, by many more people than ever before. Certainly the thousands of R.A.F. aircrew trainees and few score newly recruited R.A.F. forecasters learned for the first time that weather forecasting was not merely a matter of testing the dampness of seaweed, but a highly organized system of interchanging information from many different countries, of drawing up maps of weather conditions at frequent intervals throughout the day and night, of analysing what had just happened in an attempt to forecast what was just about to happen. What the road map is to the motorist so we found was the weather map to the airman; but, since the weather map was apparently out of date almost as soon as printed, speed was essential; explanations at aircrew briefings had to be as short as possible so that the rawest recruit must learn something of the weather man's technical vocabulary.

Very soon airmen and forecasters, new boys all, chatted freely in terms which not so long ago would have meant nothing to any of them. Isobars, fronts, lows, ridges of high and the like meant something; cirrus, altostratus, cumulonimbus and the like conjured up the different types of cloud without further explanation being necessary. Even such sternly scientific ideas as 'air mass of polar-maritime' or 'of tropical-maritime origin' became as familiar and as recognizable as old friends, were sketched as cartoon characters, and referred to shortly as 'P-m' and T-m'. The series of weather maps became as 'strip-cartoons', the same old characters getting up to different antics day by day. Experienced aircrew could now read the weather map and link it up with the weather outside for themselves; they needed the forecaster more as an expert adviser on likely developments and speed of weather change. No longer did the ex-City clerk, now navigator, ask 'When will this drizzle stop and what then?' He knew now that the drizzle is a characteristic antic of 'T-m' and will persist until that air mass is replaced by colder drier 'P-m', so that he now breezes into the Met. Office and comments 'T-m is a bit weepy this morning, Met.; when is P-m expected to give him the push?'

The War over, back to civilian life but with a lifelong interest in weather forecasting go many such disciples of 'Cloudy Joe'. The big snag was that the daily visit to the Met. Office to see the latest weather map was now impossible, but for a short time 'Airmet' broadcast a running commentary on the weather on the long waveband. This was ideal but was discontinued. However some newspapers now print daily weather maps; so does the Air Ministry Meteorological Office. This book was first started as an attempt to interest schoolboys and Air Cadets to read such maps and share in weather watching and forecasting as a hobby.

Then, in January 1954, the Weather Map began to be

televised daily. Our old friend the Weather Man was there to brief, not aircrew, but the general public instead. He was given, however, only five minutes or less to describe the actual map of today's weather and the forecast map of tomorrow's expected weather for the whole country. This left little time for him to explain the rules of the weather game and the general public, unlike the aircrew, had little chance to join in. Instead they had to accept the hurried forecast on its face value each day, a forecast rarely, of necessity, 100 per cent correct, and now and then very incorrect. Small wonder, then, that after a phenomenally bad summer the friendly weather adviser of wartime years becomes to the general public more often the 'prophet of gloom' or the 'discredited Air Ministry expert'.

This little book, then, is an attempt by a war-time colleague of the Weather Man to give you just that little bit of specialized weather knowledge to enable you to co-operate with him in forecasting your own local weather. You may be a cadet in the Air Training Corps or in the R.A.F. Section of the Combined Cadet Force, you may require a knowledge of meteorology as part of your school Physics or Geography course, you may be interested in weather because you have an outdoor occupation or hobby, or merely because you have to travel a distance daily to and from work, you may be a housewife interested particularly in Monday's weather only, or for reasons of health you may be confined to the house and only see the changing sky through a window. Whatever the reason for your interest in the weather, a little understanding of the Weather Man's methods of forecasting will turn the daily glimpse of the weather map into a fascinating serial story—a story in which you are actually living—and the forecasted course of which you can check and modify throughout the day as you watch the sky.

CHAPTER 1 *FIRST IDEAS*

SIMPLE weather maps are printed in several daily papers and are televised each evening. Rather more complicated ones are to be found in the Air Ministry Meteorological Office's Daily Weather Reports. Can *you* read these maps or are they meaningless 'doodles' to you? It is great fun to be able to point to any place on the map and to say, roughly, what the weather at the place was at the time for which the map was printed. It can become absorbingly interesting to attempt to forecast what the map will look like several hours ahead and what that change will mean in terms of weather sequence at any one place. Here are a few hints to help you to make a start.

You have, no doubt, at some time stood on a bridge and watched a shallow stream gurgle its way over its pebbly bed. Here the water heaps up and there it swirls like a miniature whirlpool around the various obstructions, all the time changing its depth and direction yet making its way ultimately downstream from high to lower level. That is roughly the picture a weather map seeks to give you. Only, instead of a stream bed you may be watching the whole of the British Isles and part of the adjacent Atlantic Ocean and Northern Europe from a height of many miles, and instead of water you are looking through another fluid—the *atmosphere*. This fluid is a complex mixture of air and water vapour. Five-sixths of the air and nearly all the water vapour are contained in the six or seven miles immediately above the earth. At any one place the weight of this fluid pressing on each square inch of surface can be measured using a barometer and amounts on the

average to just over 14½ lb. at sea-level or, as the Weather Men put it, the atmosphere exerts a pressure, on the average of 1013 millibars at mean sea-level.

Those wavy lines, often appearing as closed curves, on the weather map are called *isobars* and are lines joining places where the sea-level pressure is the same. In a sense isobars indicate the same thing as did the depth of water in our stream example with low-pressure areas instead of shallow water and high-pressure areas where the air is heaped up or is denser than usual.

CHAPTER 2 *ISOBARS AND WIND DIRECTION*

WE have learned that *isobars* are lines joining places on a weather map where the *pressure* is the same. The pressure is the weight of air pressing on every square inch of surface at the place.

Therefore high- and low-pressure areas can be taken to indicate the various depths of air on the earth's surface at any one particular time. Most people can imagine the shape of the hills and valleys as represented by an ordinary contour map. Just so isobars on a weather map can be taken to represent 'humps' and 'hollows' in the air immediately above the earth; moreover humps and hollows which may be covering many hundreds of square miles. The main drawback to this comparison is that hills and valleys are so solid and unchanging over perhaps hundreds of years. The areas of high and low pressure, however, are changing all the time, and the weather map is out of date almost before it is drawn! Perhaps, therefore, our first idea of likening the weather map to an overhead view of a gurgling shallow brook is the more helpful.

Isobars tell us much more. For instance we all know that water flows downhill from high level to low level; so too would the air appear to flow from high-pressure areas to low-pressure areas if the earth were at rest. But the earth is spinning on its axis carrying us with it to meet the air, making a complete revolution every 24 hours. Thus the horizontal flow of air, or *wind*, which we experience is the result largely of these two combined movements. The mathematical explanation is difficult but fortunately the result is very simple: *the wind near to the earth's surface* in the

Northern Hemisphere *blows almost along the isobars, leaving the lower pressure to the left.*

Try out this knowledge for yourself on the adjoining

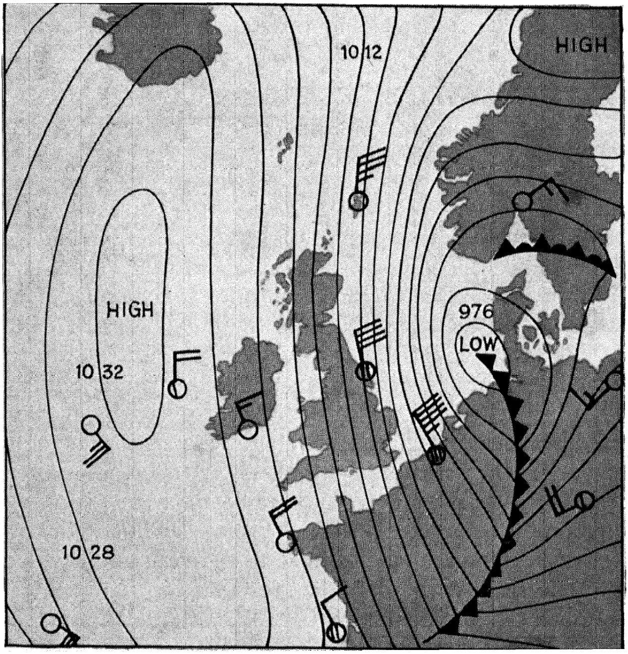


Fig. 1.—Weather Map for midnight, 31st January, 1953, at the time of the East Coast Flood Disaster

weather map. This particular map is almost an historic one now. It is the midnight map of 31st January, 1953, the time of the East Coast floods when the fiercest northerly gales for many a year swept down the North Sea and coincided with the seasonal high tides. Imagine that you are standing

with your back to the wind—where then is the lower pressure? To your left, of course!

The closeness of the isobars also tells us the speed of the wind, but this needs looking into in more detail.

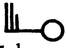
CHAPTER 3 *ISOBARS AND WIND STRENGTH*

WHERE the contour lines on an Ordnance Survey map are close together, the *gradient* of the land is steep, and any river or stream at this place will be flowing rapidly. Similarly with our isobars on our weather map. Where the isobars are close together the *pressure gradient* is steep and, were it not for the spin of the earth, the air would rush down from places of high pressure to places of low pressure. However, as explained just previously, because of the added effect of the spin of the earth, the air rushes *along* the isobars leaving the lower pressure area to the left. We can get a good idea of wind speed as well as direction from the isobars. Where the isobars are close together strong winds will be blowing along the earth's surface. Conversely, where the isobars are few and far between, light breezes are all that may be expected. The official weather forecaster uses a scale which he slides along his map to enable him to read off the wind speeds at any place by measuring the distance apart of the isobars. This gives him the speed of the wind at about 2000 ft. above the earth's surface; this is known to him as the *geostrophic wind* speed.

To estimate the likely surface wind he has to modify this speed according to the nature of the surface below. For example, surface winds far out at sea are almost as strong as the winds at 2000 ft. but over land the surface wind is generally slowed down by obstructions to as much as half the geostrophic wind speed.

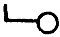
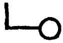
Check this up for yourself. Most weather maps show actual wind speeds reported at certain places. The wind

direction is given by an arrow which flies with the wind; its speed is given by adding feathers to the arrow. On charts drawn after 1st July, 1955 a 'half feather' indicates 5 knots, a 'full feather' 10 knots. Prior to this date the Beaufort Wind Scale was used, a 'half feather' indicating a speed of 'force 1' and each 'full feather' 'force 2'.

Thus  represents a report of a westerly wind of either 25 knots or of Beaufort force 5.

The Beaufort Wind Scale, devised by Admiral Beaufort in 1805 to standardize reports of wind speeds by ships at sea is summarized in Table I on page 12. So that you can attempt to judge wind speeds for yourself a few hints are added for use on land. Make a practice of noting the wind direction throughout the day, then try to estimate the wind speed; try, too, to notice when the wind changes its direction and speed, and later look at the weather map for about that time. By comparing the actual weather with the 'look' of the map you will soon be able to associate the two and will have made a real start in becoming 'weather wise'.

Table 1.—The Beaufort Scale of Wind Force

Beaufort number	*Description*	*Range of speed in m.p.h.*	*Symbol*	*Wind effect inland*
0	Calm	0 to 1		Smoke rises vertically.
1	Light air	1–3		Direction shown by smoke but not by wind vanes.
2	Light breeze	4–7		Wind just felt on face, leaves rustle. Vane moved.
3	Gentle breeze	8–12		Leaves in constant motion. Small flag extended.
4	Moderate breeze	13–18		Raises dust and loose paper. Small branches move.
5	Fresh breeze	19–24		Small trees in leaf begin to sway. Crested wavelets.
6	Strong breeze	25–31		Large branches move. Wind heard in telegraph wires. Spray begins to fly.
7	Moderate gale	32–38		Difficult to walk against. Whole trees sway.
8	Fresh gale	39–46		Breaks twigs off trees. Generally impedes progress.
9	Strong gale	47–54		Chimney pots and slates removed.
10	Whole gale	55–63		Seldom experienced inland. Trees uprooted.
11	Storm	64–75		Very rarely experienced except in gusts. Widespread damage.
12	Hurricane	above 75		

CHAPTER 4 *ISOBARS AND WEATHER*

SO the isobars on our weather map tell us the horizontal wind speed and direction at 2000 ft. above the Earth's surface. Do they tell us anything, however, of the likelihood of cloud, rain or fine weather at a given place on the map? They do if we know what to look for. It is sufficient for the moment to learn to recognize the weather associated with various parts of the isobar map and to leave until later the explanation of why it should rain here or be fine there.

Look carefully at the surface weather map in fig. 2*a*. The

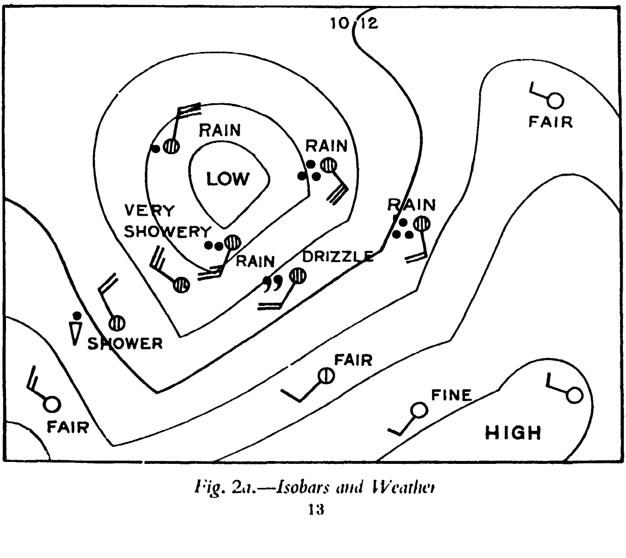


Fig. 2a.—Isobars and Weather

'Low' or low-pressure area around which the isobars show the wind blowing approximately in circular paths in an *anticlockwise* direction is known as a 'Depression'. It can be regarded as a 'hollow' in our atmospheric stream but is behaving more like a whirlpool with the air spiralling upwards and outwards and is noted for its cloudy, rainy, windy weather.

On either side of the 'depression' is a 'ridge of high pressure' where the air is heaped up and spilling over, and where the weather is likely to be fair though probably quickly giving way to more cloud and rain as another depression swirls along. Farther away from the depressions, however, the isobars are wider apart and actually enclose a high-pressure area or 'anticyclone'. Around this area the isobars show gentler winds blowing in a *clockwise* direction;

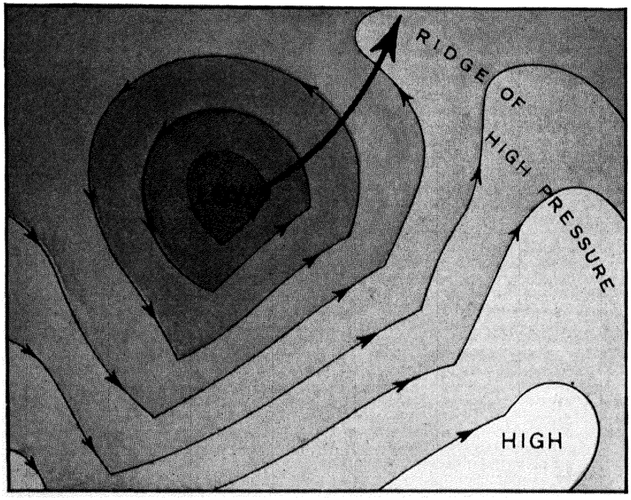


Fig. 2b.—This is fig. 2a shaded as if it was a contour map to show the Low as a deep whirlpool moving in the direction indicated by the large arrow

it is noted for its quiet dry weather. The anticyclone is generally slow-moving and may indicate a long period of fine warm weather in summer, but in winter frequently means frosty nights and, particularly in smoke-polluted industrial areas, gloomy foggy 'smog' conditions. A really well-developed anticyclone can be looked upon as a 'hump' in our atmospheric stream. To use our stream analogy again, it stands like a pebbly mound against which the whirlpool of a depression batters as if attempting to sweep it away; sometimes the depression succeeds, more usually it swirls along the edge of the anticyclone gradually losing its strength and even its identity, but the assault is only to be resumed later by a more youthful successor.

All depressions are not equally vigorous, nor is it everywhere equally cloudy and rainy in any one depression. Let us look more closely at a weather map.

CHAPTER 5 *OUR FLIGHT THROUGH A 'TYPICAL DEPRESSION'*

NO two depressions are identical, nor are they likely to take exactly the same path at the same speed otherwise weather forecasting would be a less difficult task than it is. They do, however, exhibit quite definite similarities; take fig. 3 therefore as a typical ex-

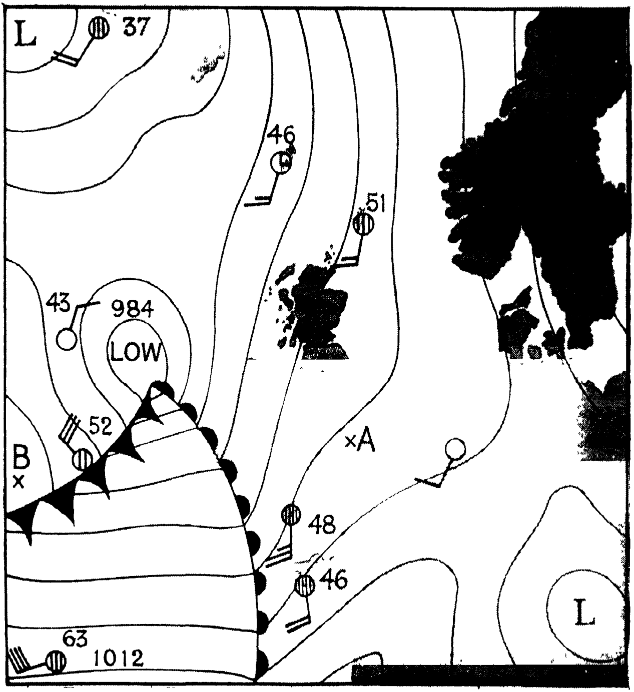


Fig. 3.—Weather Map for midday, 3rd November, 1953. We fly from A to B and back again to A

ample, but be prepared to modify conditions when applying your knowledge to other depressions. If you look closely you will see that each closed isobar is 'kinked' away from the depression centre in at least one place. A line sketched through the kinks in adjacent isobars will indicate a 'trough of low pressure'. This trough, to the best of my knowledge, was never drawn in on the T.V. Weather Chart until January 1954, presumably because it would make the map too complicated for the average viewer, but it is always included in Air Ministry Daily Weather Charts and, with a little knowledge on the part of the viewer, actually simplifies the map. The trough simply indicates a belt of bad weather; conditions at a given place deteriorate as the trough advances and improve, at least somewhat, after it passes through.

Our depression here is young and fairly vigorous and there are two such troughs noticeable to the south-west of the centre. The first one, usually indicated on detailed charts thus is called a *warm front* for reasons we can discuss later; this is followed by a *cold front* indicated thus . The area between these two fronts is known as a *warm sector.*

Suppose we take a flight in a low-flying aircraft from a place A, in the Midlands, just after dawn early in November and fly westwards from the 'ridge of high pressure' ahead of a depression right through a warm front marked on the map as approaching south-west Ireland, then through the cold front to a place B out in the Atlantic Ocean. What change of weather do we see? At A it is a fine morning with a clear blue sky and a light south-westerly wind. As we approach the coast of Wales we see thin wispy high cloud to the west which gradually spreads over the whole sky giving the sun a 'watery' look. This layer of high cloud is called *Cirrostratus* and is the advance warning of the warm front still some 400 miles to our west.

Fig. 4.—Cirrus Cloud. The first warning of an advancing depression

Fig. 5.—Cirrostratus Cloud. The high layer cloud has increased steadily from the west. The small cumulus-type cloud below is a local effect and will probably soon disperse

Fig. 6.—Altostratus Cloud and a lower scud of Nimbostratus from which rain ahead of the warm front has just started to fall

Fig. 7.—Stratus Cloud enveloping the higher ground, typical low cloud, hill fog, and drizzle of the warm sector

Now another 50 miles on the layer of cloud has lowered and thickened, though it is still possible to see the sun through it as though we are looking through frosted glass. The cloud sheet we now call *Altostratus* or medium-layer cloud. The wind has increased a little and backed to southerly. The cloud continues to lower, the sun no longer shines through, and we notice the first few drops of rain though the cloud base is still well above our aircraft. The warm front is about 300 miles away.

From now on the conditions get steadily worse, the cloud thickens and lowers so that we can no longer avoid it, the rain is continuous, and the wind has freshened almost to gale force and has backed farther almost to south-east. For nearly the next 100 miles we fly almost at sea-level in and out of scudding rain cloud. This cloud is called *Nimbo-stratus*. Quite suddenly the rain gives way to a fine drizzle, the wind veers south-westerly and decreases somewhat, banks of sea fog partially hide the sea from our sight: we are through the warm front and into the *warm sector*. Climbing through the low cloud or *warm air stratus*, as it is called, we are on top at about 2500 ft. with the sun shining above us from a clear blue sky. Below us a uniform layer of stratus cloud blankets out the sea and reminds us of the fog banks and drizzle left below. Looking back to the east in the direction from which we came we see the rain clouds along the warm front towering high above but broken here and there into layers at several levels. To the west we have still to meet the cold front—but that merits a special chapter all to itself.

CHAPTER 6 *WE MEET A 'COLD FRONT'*

CONTINUING our flight westwards through the warm sector above the thin layer cloud at 2500 ft., we soon see to the west a veritable fairy castle of cloud billowing almost vertically upwards, higher even than did the layers of warm-front cloud which we recently left behind. This cloud, known as *Cumulonimbus*, extends in an almost continuous line ahead of us and is surmounted by an anvil-shaped fibrous veil of cirrus cloud shining white in the morning sunshine. This high cloud rapidly spreads over us, blotting out the sun, and the fairy palace below it takes on a more ominous look, reminding us of a thundery summer sky. The stratus below us is now broken, and through a gap we fly down almost to sea-level.

The wind has backed again to south-south-west and has increased in strength and become increasingly 'gusty'; 'white horses' are showing on the waves below. Now the rain comes lashing down in heavy showers. The cloud base is down to 600 ft. and gathers into a dark forbidding roll as we head towards it. The rain is heavy, there is hail and a flash of lightning; the conditions are extremely bumpy. This is the cold front; suddenly we are through it, the clouds break and we can see the sun shining through gaps in the frontal cloud now to our east.

The wind has veered markedly to north-westerly and though still fresh has decreased. We can see for miles in the clear air; there is no trace of sea fog below us now. We encounter another shower but this is soon passed. It seems a pity but we must turn around and head back the way we came.

Fig. 8.—Cumulonimbus '. . . the fairy palace ahead of us takes on a more ominous look as we approach the cold front'

On our return trip the weather sequence is repeated but in reverse, though we notice that the fronts have apparently moved eastwards during our absence at about 30 m.p.h. First comes the thundery rain belt of the cold front with its bumpy conditions, though we notice no hail or lightning this time. This gives way to the thin layer cloud and damp drizzle and sea-fog of the warm sector, then the continuous rain of the warm front, easing as we leave the front far to our west to become intermittent, the cloud lifting and brightening all the time.

When we land at our airport A early in the afternoon, after a round trip of some 1600 miles, though the blue sky of the morning has become overcast by high clouds from the west there has been as yet no rain and we are able to visit the local Weather Man's office and confirm his forecast that, though rain is on the way from the west, it will not be continuous here until early evening. With his help, too, we are able to draw a cross-section of the clouds and

weather encountered on our flight from A to B (see fig. 9) and he is good enough to explain the causes of the weather sequence—but more of this next time.

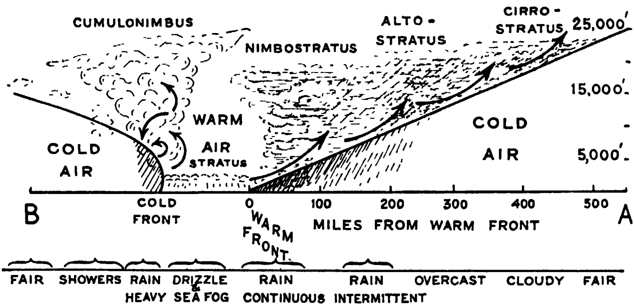


Fig. 9.—A vertical cross-section of the cloud and weather encountered on our flight from A to B on fig. 3

CHAPTER 7 *WHY CLOUD AND RAIN?*

THIS is the gist of the Weather Man's explanation. The atmosphere, as we already knew, consists of air mixed with a variable amount of invisible water vapour, and five-sixths of this air and nearly all the water vapour are contained in the first six or seven miles immediately above the Earth. This zone, known as the *troposphere*, contains practically all our weather phenomena. The zone above the troposphere is known as the *stratosphere* and does not enter into this account. If a sample of air near the earth's surface is lifted by some means, it finds itself at a lower pressure since there is not so much air above it. It therefore expands and in so doing it cools. To use the correct term, it cools *adiabatically*. (A simple example of the reverse process, that is of air *warming adiabatically* by compression, is noticed by anyone pumping up a bicycle tyre quickly; the end of the pump soon becomes uncomfortably hot to the touch.)

If the air continues to lift and cool, it reaches its *dew-point* of temperature when it becomes saturated with its own water vapour, that is, it can hold no more water vapour in the invisible state. Further cooling means that it releases some of its water, tiny droplets condensing on dust or dirt or salt particles or charged particles in the air, and thus a cloud is born. There are now two possibilities. If the lifted air finds itself surrounded by cooler or denser air, like a balloon, it continues to rise 'convectively'. If, on the other hand, its surroundings are warmer and lighter than itself, it sinks and warms adiabatically and the cloud disperses. This lifting, whether due to buoyancy or to other causes

explained later, is typical of low-pressure areas as is 'subsidence' typical of high-pressure areas.

We saw plenty of cloud, and worse, on our recent flight. What caused the lifting there to produce the clouds? To understand this we must think back to our first chapter. There we likened our weather chart to the view we should get from a height of many miles above the Earth when watching the Earth's atmosphere swirling along below us. We said that the atmosphere was a fluid; a complex mixture of air and water vapour. To be more exact now, the atmosphere can be considered to consist of several such fluids or *air masses* as they are called. Our depression is the result of at least two such air masses meeting.

At the sea surface hundreds of miles away in mid-Atlantic a cold, dense, moist air mass pushes southwards from polar regions; it is called a *Polar maritime* air mass, P-m for short. Eventually it meets a very different air mass which has pushed northwards from the sub-tropics; this air mass is warm, very moist and much less dense than P-m and is known as *Tropical maritime* or T-m for short. For a time P-m and T-m appear to run agreeably alongside, usually in an east-west line, their boundary on the sea surface being called a *Polar front*. The word 'front' reminds us of a battle line separating two enemies and so it proves to be. At some point on this front (and exactly why at that precise point it is difficult to explain) a battle does begin. The first indication is that the polar front develops a 'kink', the warm air pushes gently north-eastwards over the cold air, the cold 'retaliates' by 'nosing' its way violently under the warm air. Soon more and more air is drawn into the conflict and circulates around the kink, and a depression or centre of low pressure is formed, around which the air is moving in an anticlockwise direction. At the same time the tongue of lighter warmer T-m is spiralling upwards above the denser P-m and the whole whirlpool begins to

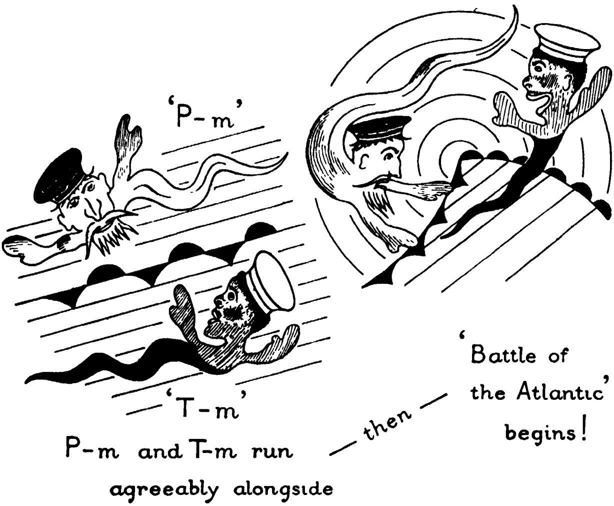


Fig. 10.—*Two of the three principal characters in our Weather Serial*

move, generally in a north-easterly direction around the 'hump' of anticyclone.

A depression which is drawing in more air and increasing its activity is said to be 'deepening', and the pressure at its centre will be falling rapidly. Eventually the depression loses its impetus, the circulation becomes less violent as the warm-air sector is overrun by the cold and the intruding tongue of T-m is lifted high above the surface of the Earth; the conflict of the air masses is over for the moment and the depression is said to 'fill up'.

The time taken for a depression to form, to deepen, and, finally, to fill up may be several days. In the meantime its centre may have travelled well over a thousand miles, and the whole of the North Atlantic and Western Europe may have been affected by the movement of its air masses.

Somewhat rudely and not a little impatiently we interrupt the Weather Man. 'Yes, but what of the rain, drizzle, fog and showers of our recent flight? How do these fit into the life history of the depression of which we have just heard?' He explains; and we begin to appreciate the enormous task undertaken by the Air Ministry Meteorological Office and its counterpart in other countries.

CHAPTER 8 *A 'STILL 3-D PICTURE' OF OUR FLIGHT*

SOMEWHAT surprisingly the Weather Man asked us if we had ever looked at a ciné camera film! It consists of a large number of photographs taken at very short time-intervals. Each frame differs a little from its neighbour and, if they are projected at the correct speed, we see a continuously moving picture on the screen. If the projector is stopped suddenly we can examine at leisure a 'still' picture. For example, in a film of a cricket match we may stop the film just as a bowler is about to deliver a ball and we may examine his action in detail.

The weather map may be regarded similarly as a 'still' taken of our swirling atmosphere from above at one particular instant of time. Such weather maps are drawn every three hours throughout the day and night, year in, year out, providing a remarkable example of international co-operation. Shortly before each 'synoptic' hour an observer at each of the very many observing stations on land and sea throughout the world records his or her weather conditions. Observations of present weather, pressure, pressure change since the last report, temperature, humidity, details of cloud type, height and amount, wind direction and strength, visibility and various other phenomena are made and encoded into a number of five-figure groups. This is the International Weather Code (see fig. 11) which thus presents no language difficulties.

Each country collects its own observations as speedily as possible by telephone, telegram, teleprinter, or radio and issues the 'collective' to its own forecast centres and inter-

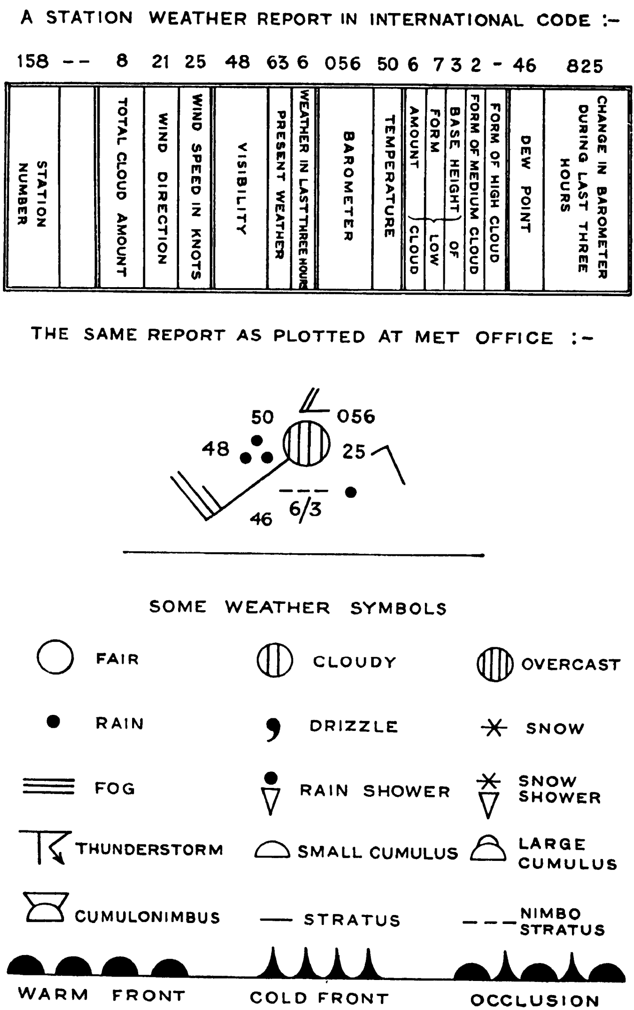

A STATION WEATHER REPORT IN INTERNATIONAL CODE :-
158 -- 8 21 25 48 63 6 056 50 6 7 3 2 - 46 825
STATION NUMBER
TOTAL CLOUD AMOUNT
WIND DIRECTION
WIND SPEED IN KNOTS
VISIBILITY
PRESENT WEATHER
WEATHER IN LAST THREE HOURS
BAROMETER
TEMPERATURE
AMOUNT
FORM
BASE HEIGHT
OF LOW CLOUD
FORM OF MEDIUM CLOUD
FORM OF HIGH CLOUD
DEW POINT
CHANGE IN BAROMETER DURING LAST THREE HOURS
THE SAME REPORT AS PLOTTED AT MET OFFICE :-
50
056
48
25
46
6/3
SOME WEATHER SYMBOLS
FAIR
CLOUDY
OVERCAST
RAIN
DRIZZLE
SNOW
FOG
RAIN SHOWER
SNOW SHOWER
THUNDERSTORM
SMALL CUMULUS
LARGE CUMULUS
CUMULONIMBUS
STRATUS
NIMBO STRATUS
WARM FRONT
COLD FRONT
OCCLUSION

Fig. 11

changes information by radio with other countries. So speedy is the interchange of information that, within an hour of making its observation, a weather-forecasting office receives in exchange the observations from all parts of Great Britain and Eire and from a good number of Continental and Atlantic reporting stations. The ingeniously coded numbered messages are quickly plotted on a blank map using an equally ingenious pictorial code by an assistant. The forecaster then analyses the mass of information, drawing in the isobars and fronts, and noting the depression centres, air masses and the like. By comparing the current chart with the previous ones he must attempt to forecast the likely sequence of weather in the immediate future.

The forecaster's chart is a good deal more complicated than the simplified version issued to us. He also receives and analyses a great deal of additional information which is too complex for us to consider but which enables him to form a good picture of what is going on not only on the surface but at all levels in the atmosphere up to a height of well over seven miles.

Our chart then is a 'still' picture of what was happening at one particular time. It is, however, only a 2-dimensional plan of what is happening at the earth's surface. If we wish to look at it with a forecaster's eye we shall have to make it '3-dimensional'—3-D in fact—we can do so by using our imagination and new-found knowledge. Let us try it on the weather map of our recent flight.

The chart for 1200 hours—or midday to us—is the nearest still picture we have of surface conditions (see fig. 3). Now try to get the 'feel' of this chart in 3-D. It may help to look at it first as a contour map. As we fly towards the warm front, though we keep at a constant height above the ground, it is as though we were moving downhill. On a contour map we should be losing height; on a weather

map we are 'losing' pressure, that is, the air column above us is losing weight. On crossing the warm sector the contour map suggestion is that of crossing a valley which is level along our route but tilting downwards to the north; on our weather map our pressure level remains the same. At the cold front and westwards the contours suggest that we are climbing again out of the valley, but in fact it is the pressure which is again rising. So too, in our own homes, though we ourselves are not moving, a falling barometer indicates the approach of a front and usually bad weather, and a rising barometer that the front has passed and we can hope for improving conditions.

Now let us use the cross-section of our flight in fig. 9. This we should try to imagine standing upright on the chart along our route to give depth to our flat chart, so that we see it in 3-D. At our airport A the cold air mass ahead of the warm front is over four miles high, but it tapers to sea-level at the front itself. The lighter, warmer, moister T-m air is at the surface in the warm sector but is streaming fairly gently above the wedge of denser cold air in advance of it. The cloud we saw on the flight then is thus due to this moist warm air rising over the cold, so that at first we saw only thin wispy cirrus at well above 20,000 ft. Incidentally, the wispy fibrous appearance of this 'cirrostratus' is due to the temperature at that height being so low that all the condensed water vapour particles are in the form of ice crystals. Water vapour in the atmosphere does not necessarily condense as ice crystals at the usual surface freezing-point of 32° F., more usually it exists as 'supercooled' water drops until about 20° F. is reached. The so-called 'freezing level' of 32° F. is rarely above 12,000 ft. in this country and may of course be at or near the surface in a particularly cold wintry air mass. The danger of supercooled water vapour is that it may suddenly turn to ice if rudely disturbed, by an aircraft for instance;

the aircraft may suddenly become 'iced-up' if not fitted with a de-icing device. But we digress.

To return to our cross-section. As the warm air lowers, the cirrus cloud base lowers and thickens to become alto-stratus; more water vapour condenses on the ice crystals, which finally become heavy enough to fall out of the cloud and, melting, fall as rain. Hence the dense cloud with its very low base from which is falling the continuous rain which we met as we approached the warm front. This frontal cloud we call nimbostratus, that is, layer cloud from which rain is falling.

In the warm sector there is only one air mass above us, there is no great tendency for this air to lift and therefore no cloud formation above the thin drizzly sheet of 'stratus' formed by the warm moist air travelling over the colder sea. If this warm sector had been travelling overland in warm summer sunshine, we might have seen the stratus break up and disperse to give us a mild and pleasant interlude.

We might at this point pause to note that our cross-section is not drawn to the same scale horizontally as vertically, and the slopes of the two wedges of cold air are greatly exaggerated. The lifting of the warm air over the cold air ahead of the warm front has not been much more than four miles up in about 600 miles along our route. Consequently all the pre-frontal cloud formed has been due to a gentle lifting giving layer or 'stratus' type clouds.

At the cold front the denser cold P-m air mass is nosing its way much more violently under the warmer T-m. The slope of this wedge is much steeper than the other and is usually about one mile up in a distance of eighty miles. Great bubbles of warm air are thrown violently upwards, resulting in the formation of masses of 'heap' or cumulus cloud. A small cumulus cloud may be quite a pleasant sight on a warm summer morning, but at the cold front it

rises rapidly to become 'large shower cumulus' and often 'cumulonimbus', the cloud of thundery downpours. Cumulonimbus is recognized by its 'anvil-shaped' top, often over four miles high, consisting of ice-crystals. The rapidly ascending air currents inside the cloud often force water droplets, which have condensed on ice crystals and are in the act of falling out of the cloud, back again to the upper part of the cloud. Here they may freeze again, collect more condensed water vapour, start to fall again, only to be lifted up once more. This juggling act inside the cloud may go on for quite a time, the droplets increasing in size on each visit to the upper cloud region. Finally they are heavy enough to fall out and may reach the ground as hail or, if they have just managed to thaw, as unusually large raindrops.

The rapidly ascending air may break up these large drops

Fig. 12.—Cumulonimbus is recognized by its anvil-shaped top. Note the sharply defined cloud base from which hail is falling on the right of the photograph

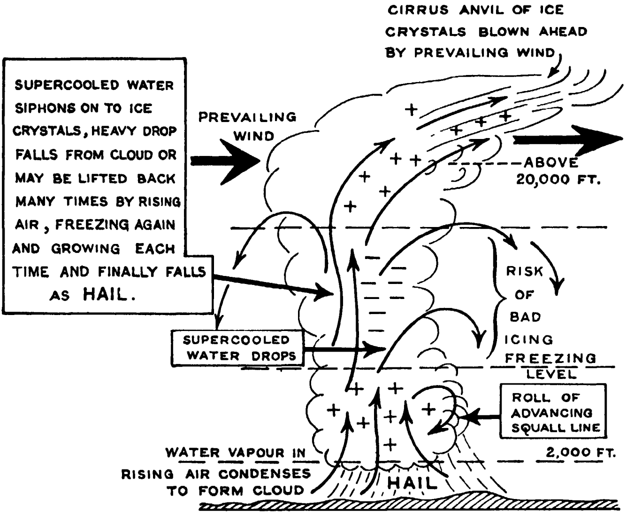


Fig. 13.—*This diagram shows what is happening inside a Cumulonimbus Cloud* (*fig.* 12)

into a finer spray near the base of the cloud and also stir up the ice crystals nearer to the top; both acts tend to cause electrification by friction, so that the cloud becomes an electrical 'sandwich' with positive charges usually at the top and bottom and a negative charge in the middle. If this natural power pack reaches a high enough voltage, it discharges itself through the air by lightning flashes either from cloud to cloud or from cloud to ground. The flashes we see demonstrate the great amount of heat generated; this heat causes sudden and concentrated expansion of the air in the path of the flash, and the shock wave produced we hear as thunder. The flash we see almost instantaneously, the sound reaches us at about 1100 ft. per second. So, to judge the distance of a lightning flash, time the interval between

flash and thunder clap in seconds, divide by five and the answer is near enough the distance in miles.

Our cold front was a comparatively feeble affair, however, with only the suggestion of thunder. As we fly westwards away from it towards our turning point at B, the battle of air-masses is over for the time being, and, though there are a few skirmishes producing occasional shower belts, the clear bright blue sky of the cold air mass predominates; all that remains of the warm-air 'uplift' is broken layers of altocumulus very far above us. Farther west we are once again in a 'ridge of high pressure'; the air above us is, if anything, gently subsiding and warming adiabatically, so that the conditions are not favourable for cloud formation. For a few hours here at least the weather is set fair until the warm air of the next depression starts to move in. However, as we sometimes hear said at the cinema, 'This is where we came in!'

CHAPTER 9 *A 'MOVING 3-D' PICTURE*

SINCE the weather chart can be regarded as a 'still' photograph of our swirling atmosphere taken at one particular instant in time let us take a tip from the films and try to get a moving picture. Weather maps we have been told are drawn every three hours, so that we can borrow a few for our experiments. Charts A–F (pages 37–47) are those drawn at intervals of six hours and covering the period of our flight from 6 a.m. on the 3rd of the month until midday of the next day. These charts have been printed conveniently on succeeding right-hand pages so that by flicking these pages over we get a continuous, if somewhat jumpy, moving picture of the weather. Once again, of course, we get only a flat surface plan of the moving atmosphere but by using our imagination and knowledge we can see the picture in depth too, in 3-D.

First recall that the isobars represent the near surface wind, giving us its direction, and that the nearer together they are the greater is the wind speed. Chart A shows us a depression centre well to the west of Ireland with a roughly circular isobar showing the wind blowing in an anticlockwise direction. But the centre is moving too and getting deeper all the time. Flick over the pages and see it move north-eastwards well to the north of Ireland, then skirting the Outer Hebrides and North-West Scotland to the Shetland Isles. Imagine the change of wind, say in Shetland, during this period of thirty hours; first light southerlies, then freshening south-easterlies, then gales from east to south-east, suddenly changing direction to south-west or

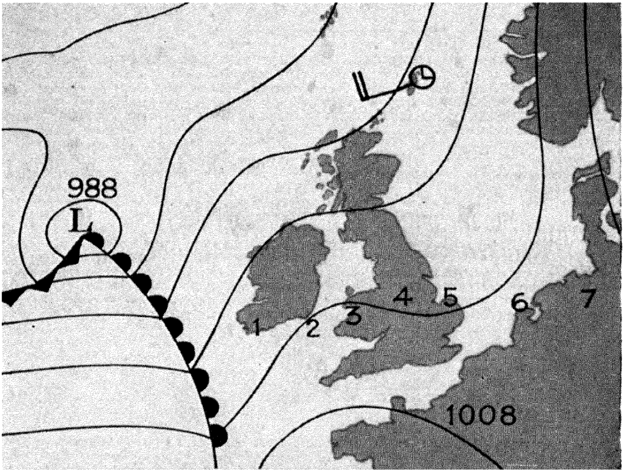


Fig. 14.—Chart A for 6 a.m 3rd November, 1953

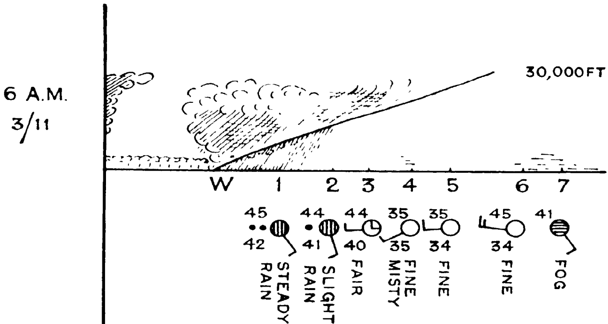


Fig. 15.—Vertical cross-section of the weather likely to have been encountered on a flight from S.W. Ireland to S. Denmark at the time of Chart A and the actual weather reported by six stations on this route.

Similar charts and cross-sections have been printed exactly underneath these on the next five right-hand pages for intervals of six hours. Flick over these pages to obtain a moving picture of the weather over a period of thirty hours.

west as the front moves through on the morning of the 4th.

And what of the front? Notice that the cold front, true to form, catches up the warm front, so that the warm sector decreases in size and only affects the southern half of England and by midday of the 4th on Chart F appears to have disappeared altogether. There is only one front drawn on this chart extending from the north of Shetland almost to Denmark then well through Holland and half-way across France. The two original fronts of our flight on the previous day are said to have 'occluded' or merged into a single *occlusion* represented on the map thus:

Let us try to picture this occlusion in depth, in 3-D; to help us, underneath each of the six-hourly charts has been drawn a vertical cross-section of the weather likely to have been encountered on a flight from S.W. Ireland to the Dutch coast had we been flying at the time of each chart; they show the type and amount of cloud up to about 30,000 ft. above the Earth's surface. Below each cross-section, too, has been drawn part of the actual weather on this route reported by six stations, one each in S.W. Ireland, S.E. Ireland, N.W. Wales, the Midlands, the Norfolk Coast and in N. Holland. Some reports from S. Denmark are included too.

Flick over the pages a few times but concentrate only on one thing at a time. First notice how the pursuing P-m air mass from the west catches up with the other cold-air mass to the east and by 6 a.m. on the 4th has forced the intervening warm T-m air mass off the surface, so that there is now no warm sector on our route. The warm air is still climbing up the eastern wedge of cold air and is being thrown up more violently by the 'nose' of colder air to the west, so that we continue to have much cloud and some rain.

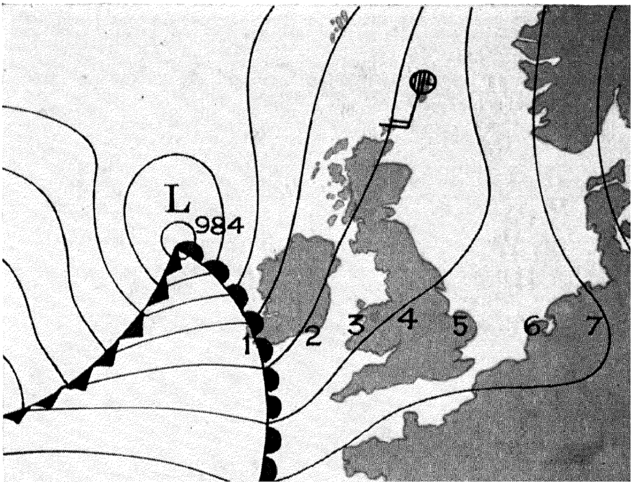


Fig. 16.—*Chart B for noon 3rd November,* 1953

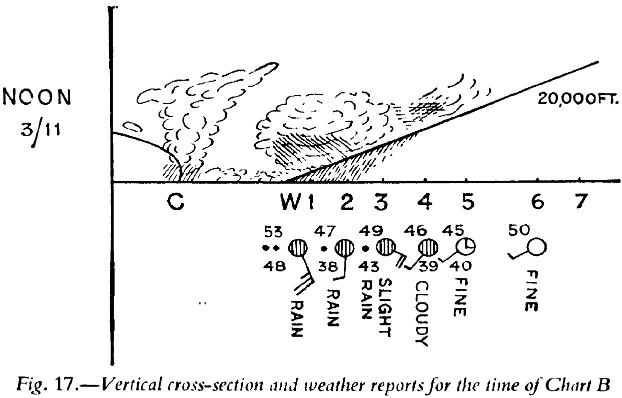


Fig. 17.—*Vertical cross-section and weather reports for the time of Chart B*

The main difference now is that the frontal belt is narrower than formerly, since the warm and cold front zones have been telescoped into each other. An occlusion then presents a narrower belt of bad weather to an aircraft flying through it than does the earlier sequence of warm front, warm sector, cold front. The duration, however, of the rain to us on the ground depends very much on the speed with which the occlusion is passing over us.

In the example we are considering the occlusion and its bad weather belt was quite fast-moving, particularly across Northern England and Southern Scotland. It does sometimes happen that an occlusion becomes almost stationary and you, for instance, may experience many hours of dull and maybe rainy weather and yet some fifty miles away the weather may be quite fair.

Fortunately the now familiar isobars come to our aid in estimating the likely speed and direction of movement of fronts in general and of occlusions in particular. We know that they give us the wind speed and direction at about 2000 ft. above the surface. The warm front can be imagined to advance as fast as the winds in the cold wedge ahead but in the direction of the winds in the warm sector, and the cold front will advance as the winds immediately behind it in the colder air. After the fronts occlude the movement of the occlusion is decided roughly by the push of the winds immediately behind it. Where, therefore, the isobars are close together and kink only slightly at the front, quite rapid movement is to be expected, but where the isobars are far apart and the kink or trough of low pressure is very pronounced, as over France on the midday chart of the 4th, the movement of the front is very slow.

Now concentrate on each of the station weather reports in turn as the pages are flicked over; notice the gradual deterioration in weather as the warm front or occlusion approaches and the rapid improvement at the passage of

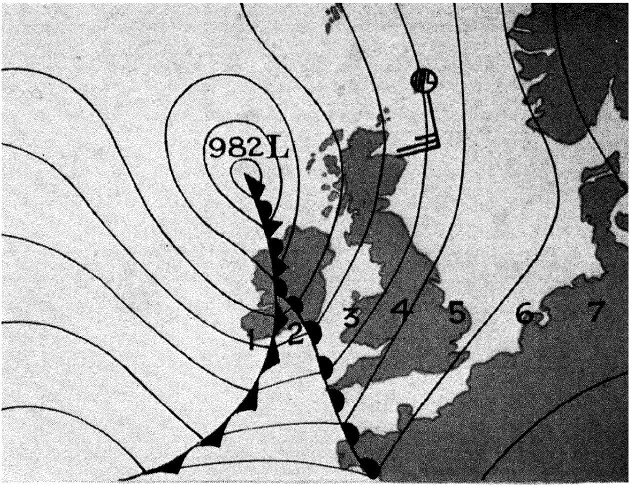


Fig. 18.—*Chart C for* 6 *p.m.* 3*rd November,* 1953

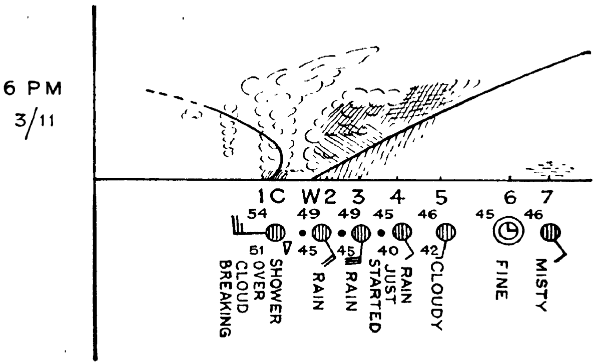


Fig. 19.—*Vertical cross-section and weather reports for the time of Chart C*

the cold front or occlusion. Notice, too, the gradual change in surface wind direction and strength, and the sudden veer to the west or north-west in the colder air. These changes can be very much more violent in other similar situations.

Consider, too, the temperature changes at each station as the air masses move across. The figures to the top left of each station circle are the air temperatures in degrees Fahrenheit. Each station by international agreement keeps its thermometers at 4 ft. from the ground in the same sort of screen or louvred cupboard, looking something like a wooden beehive. This screen is always out of doors, standing above level well-trimmed open ground clear of obstructions. Its door always opens to the north so that the direct rays of the sun do not fall on the thermometers being read. These are the temperatures mentioned in official reports and forecasts and may differ considerably from those recorded by you at home unless your thermometer is similarly housed. Incidentally, in these reports 'ground frost' means that the temperature on the ground is below the freezing-point of water of 32° F. though the screen temperature at the same time may be higher. 'Air frost' means that the screen temperature is below freezing-point too.

Air temperature is not, however, a good guide to a change in air mass, as it is affected also, for instance, by the time of the day and the locality of the station. Even though the air mass at a station does not change, there may be considerable difference in afternoon and early morning temperatures, particularly if the station is well away from the sea. A much better guide is the temperature written to the bottom-left of each station circle; this is the 'dew-point' temperature.

We need not consider how this is measured at the moment. All we need to remember is that, as previously explained to us, if the air temperature and the dew-point are the same, then the air is saturated with its own water

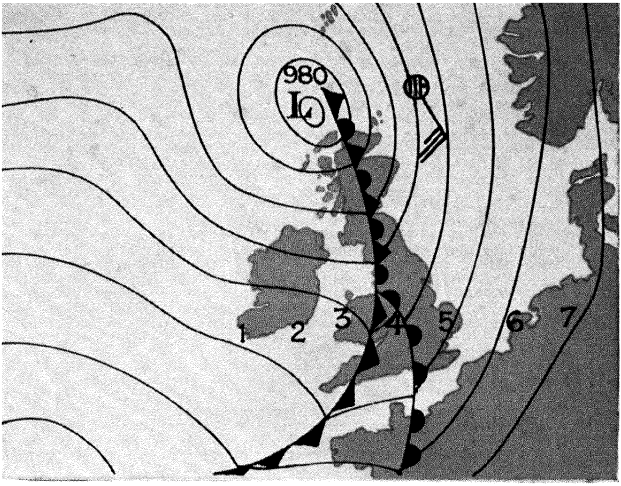


Fig. 20.—*Chart D for midnight 3rd November*, 1953

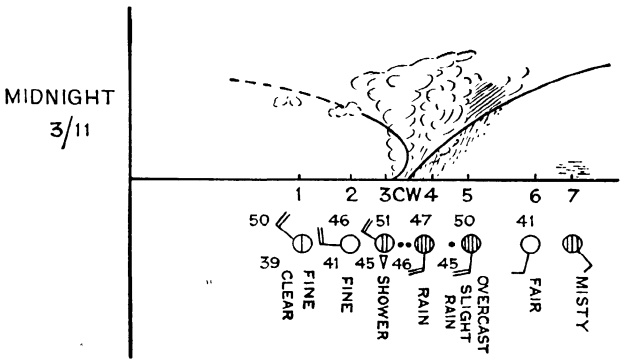


Fig. 21.—*Vertical cross-section and weather reports for the time of Chart D*

vapour, and further cooling causes condensation of water from the air either as cloud or fog or dew. A cold dry air mass therefore has a low dew-point and, in mid-afternoon at least, a much higher air temperature; a warm moist air mass has a fairly high dew-point and the air temperature is generally not much higher. Notice the change in dew-point therefore at a station as one air mass replaces another. We have already seen that pressure changes at the passage of a front are also marked and are a great help to forecasters in sorting out the air mass and frontal changes but, in an attempt to keep the diagrams fairly simple, these have not been recorded here.

Many other factors, of course, have to be taken into consideration by the forecasters. The movement of the depression centre itself is difficult to forecast, particularly as it approaches a well-established 'hump' or 'high' or anticyclone. Such a 'high' is frequently met over the Continent in winter. The general tendency is for the depression centre to swirl north-eastwards around the top-side, so to speak, of the anticyclone, as did our depression. It could also 'undercut' the anticyclone, swirling into the Bay of Biscay and into Central France, as indeed did the depression which followed ours.

In general, therefore, the occlusion lengthens and slows up as it approaches the Continent and its belt of bad weather becomes narrower. Remember too that all the time the warm T-m air mass is being lifted higher and higher away from the ground and is losing its moisture so that eventually the rain ceases and all that remains of the front is a belt of fairly high cloud. This is particularly so at the southern end of the front where the pressure is high and the cold air masses are shallow. Towards the depression centre, however, the cold air is much deeper, so that the rising warm T-m air finds itself in 'enemy territory' to much greater heights, and the occlusion persists as

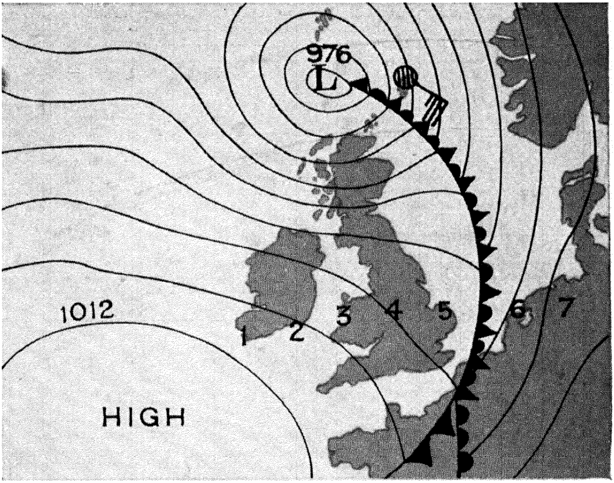


Fig. 22.—Chart E for 6 *a.m.* 4*th November,* 1953

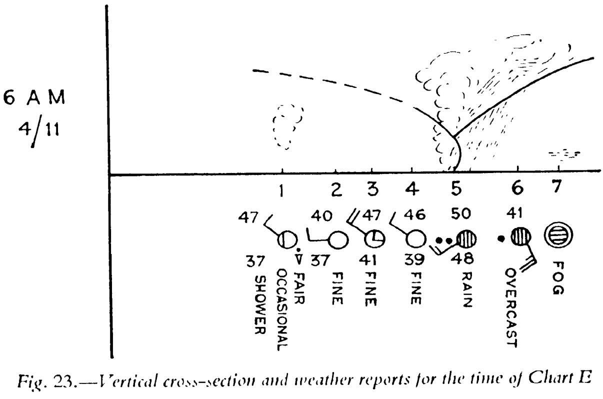


Fig. 23.—Vertical cross-section and weather reports for the time of Chart E

a bad-weather belt much longer than farther away from the centre.

This effect is noticeable too behind the frontal zone. In the south the ridge of high pressure quickly establishes itself as the cold front or occlusion passes, and a cloudy belt with perhaps a little rain is quickly succeeded by fair conditions. As we move north, however, the showery tendency increases in the P-m air behind the front until the 'bright intervals' between the showers become so short as to be hardly noticed as we approach the depression centre.

The actual track of the airstream and the time of the year are important factors to remember in forecasting this shower activity. We can at least try to remember the following points. In the cold north-westerly airstream which follows a depression, showers are to be expected, increasing in frequency and in intensity as we move northwards. Since they are caused mainly by unstable cold air being heated by the warmer surface and rising like huge bubbles, they are likely to occur at any time, day or night, over the open sea which does not vary much in temperature. Over land, where the afternoon temperature is likely to be a good deal higher than during the night, there is generally a little cloud in the early morning but 'small cumulus' cloud increases during the day, and where the cold air is deep enough will develop into large cumulus and possibly into thundery cumulonimbus during the afternoon with frequent showers well inland. The showers then die out and the cloud disperses towards dusk; the night is perfectly fine and cloudless. The ground, with no protective cloud blanket, radiates its heat away and the temperature drops. If the wind is very light the forecast for inland areas may be of frost or fog in early spring, autumn, or winter, or of mist patches around dawn in summer.

These, too, are the conditions for 'April showers', for in Spring the P-m air is still very cold and the morning sun,

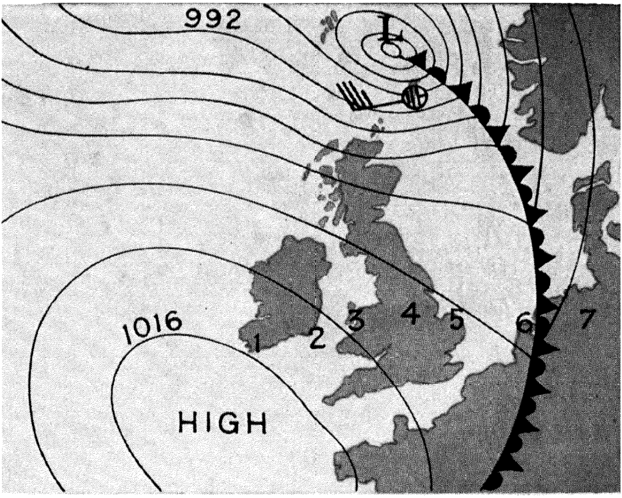


Fig. 24.—Chart F for noon 4th November, 1953

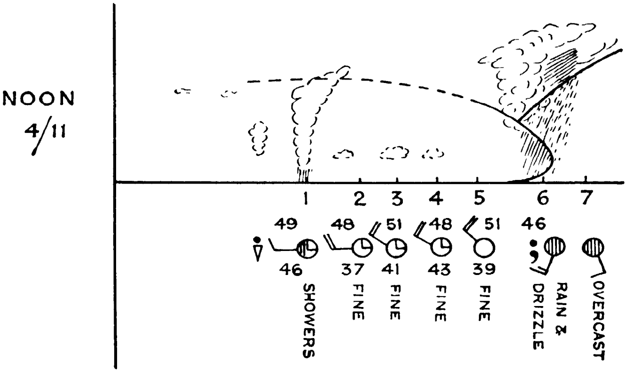


Fig 25.—Vertical cross-section and weather reports for the time of Chart F

shining through the clear air, is hearteningly warm; so much so that, conscious of the drabness of our winter clothes and the need for new attire, we venture out without our raincoats. Then, sad to relate, the ground becomes heated, shower clouds develop as if by magic, and unless we shelter between the bright intervals, we really need that new suit. Again, after dusk the sky clears and is full of stars.

At all times of the year, too, this shower activity varies in different parts of the country. As well as being more frequent in deeper cold air usually to the north, the showers are more frequent on exposed coastlines and to the windward of higher ground and in general wherever the air is forced to lift over surface obstructions. Thus in a north-westerly airstream the western coasts and the western slopes of higher ground may get frequent showers, yet in the east and on the sheltered sides of hills the day may be quite fine.

The P-m air, of course, may stream across the British Isles from directions other than north-west. If the depression centre has moved south-eastwards into France we may get a predominantly north-easterly airstream over the British Isles with most showers on the eastern coasts and on the eastern slopes of higher ground. In summer, too, a 'thundery low' developing over France may cause air, originally of northern origin, to attack us from the south, where the surface heating by day causes big temperature differences in the air mass. The annoyingly yet necessarily vague forecast then is of 'sporadic outbreaks of thunderstorm activity in the south moving northwards'—which means that, though you may be lucky and escape a storm, someone, somewhere, is going to get it!

CHAPTER 10 *SMOG OR SUNSHINE?*

SO far we have considered the rapid changes in weather as our swirling atmospheric stream floods across the country, as it were in full spate. We ought to consider, however, the rarer occasions when an *anticyclone* builds up over the British Isles and gives us a spell of more settled weather lasting for a period of days or perhaps, more rarely, for a few weeks. The type of settled weather we get depends very much on the time of the year.

We have seen that the anticyclone, or high-pressure area, can be regarded as a huge mound of heavier air around the edges of which the depressions swirl as if trying to batter it away. Some high-pressure areas may have a single centre, or peak, or may have several centres in which case we can think of them as a mountain chain with several peaks. As winter approaches, the land loses its heat much more quickly than does the sea, and in the extensive inland belt stretching from Poland across Russia to Siberia it becomes very cold indeed. The air mass above this belt therefore becomes very cold, dry, and dense, and is known as the 'Polar continental' air mass or P-c for short. The pressure of this air mass at low levels is high and a belt of anticyclones stretching across the inland belt is a regular feature of winter weather maps.

Every now and again this belt of high pressure pushes westwards across western Europe and may extend across the British Isles or may combine with an Atlantic anticyclone. Then we have the interesting struggle of Atlantic depressions against Continental high pressure, and the

British Isles is often the battle ground. In this 'Battle of Britain', ground is given up first by one side, then by the other. When the Continental side pushes westwards, the Atlantic fronts are held at bay and become stationary, unable to move eastward into the Continent, and if we are in the P-c air mass we feel the bitter cold; in eastern Britain our plight is not helped by the air having crossed the North Sea, picking up enough moisture to make it both damp and cold and possibly giving us the first light snow flurries of the winter as it hits the coastline.

On 18th November just about a fortnight after our flight the first Continental link-up of the winter with the British Isles occurred. Let us look at the 6 a.m. map for that day. There is a small anticyclone centred to the south-west of England, forming the western outpost of a Continental belt of high pressure. However we are not receiving air from the Continent, in fact there is no wind at all over southern England, with very light easterlies over northern France, light southerlies over Eire, turning light westerly over south Scotland. This would give us a very pleasant day in summer, but what do we get today—and why? The only rain, and slight and intermittent at that, according to Air Ministry records, is falling in the extreme north of Scotland and Shetlands, but this is north of the anticyclone area and is due to the slowly-approaching cold front. Incidentally notice that to the west of Scotland this is stationary and joins up with the warm front of the next depression moving north-eastwards.

Elsewhere in Scotland, in the south-westerly air stream, reports fall remarkably into two very different groups: either of overcast skies or almost cloudless conditions. In the centre of the anticyclone over England it is a very gloomy early morning, misty generally, with overcast skies and very low cloud, while in the thickly populated industrial areas of South Yorkshire and the Midlands right

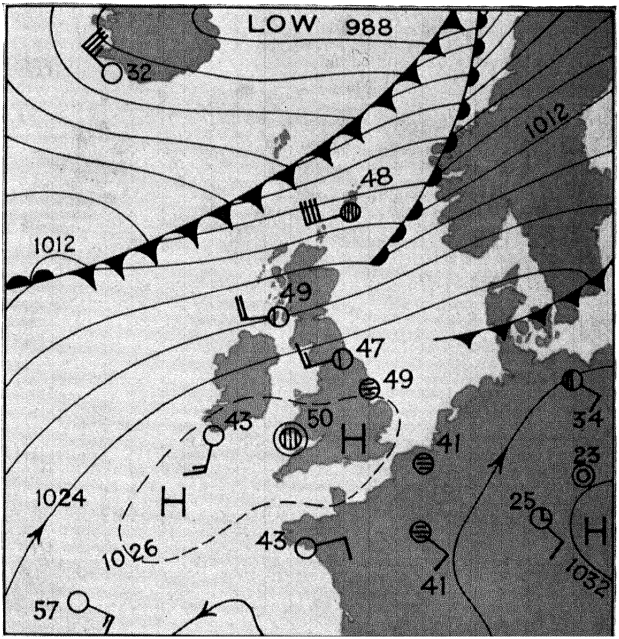


Fig. 26.—'Sunshine or smog?' 6 a.m. 18th November, 1953. Compare the temperatures in England with those in the Continental 'High'

down to the south-east coast the reports are of fog obscuring the sky and reducing visibility in places to less than 100 yards. Even here we find occasional reports, chiefly in the south-west, of cloudless skies. This then is the weather of an autumn or winter anticyclone—known to some Weather Men as 'anticyclonic gloom'. Yet we can find a weather map for June, looking almost the same as this one, in which the weather is fine generally apart from a few early morning mist patches, but, note well, these mist patches are more likely again near large towns. Why the

difference? We can put nearly all the blame on to the sun!

Just as radio stations send out radio waves on long, medium, or short waves, hot bodies send out heat rays on various wavelengths. The hotter the body, the shorter are the wavelengths of the heat rays it transmits. The sun, being a very hot body, sends out heat on very short wavelengths. (It sends out light, too, on shorter wavelengths still.) These rays nearly all pass through the air in our atmosphere without heating it but are absorbed by the Earth. The Earth then is heated by the sun, but is very much cooler than the sun and sends out heat rays of a much longer wavelength. These longer waves are apparently able to heat the air in our atmosphere.

The air then owes its heat to the sun but not directly so; it gets the heat as it were 'rebroadcast' from the earth. The air is thus normally warmer near to the surface of the earth, and its temperature drops fairly steadily as we fly upwards to the stratosphere. In a high-pressure area, particularly in a well-established anticyclone, however, we have learned that the air is gently subsiding, that is, it is falling towards the earth. We can think of it swirling up a depression centre as if up a very tall chimney and spilling over at the top on to a high-pressure area. This subsiding air is being compressed adiabatically and therefore is warming. Remember the bicycle pump example given earlier. The air above an anticyclone therefore does not decrease in temperature as we leave the earth at such a great rate as does the air in a depression. We say that its 'lapse rate' of temperature is not so steep.

Now during the night the earth is radiating heat but is not receiving any from the sun in return, and it consequently drops in temperature. Any clouds above the earth absorb this radiated heat and send some of it back to the earth, so that the fall in temperature of the earth during a cloudy night is not so marked; the cloud acts as a blanket

in fact. But in the subsiding air of an anticyclone no great cloud development is usual, or indeed is possible.

On a clear night, then, the surface of the earth becomes very cold and eventually may become colder than the first few hundred or even thousand feet of air immediately above the surface. We thus get an *increase* of temperature with height; this is called an *inversion* of temperature since it is just the opposite of the usual state of affairs.

The surface layer of air in these conditions no longer has to rise to be cooled, its temperature drops as the ground cools. It may no longer be able to hold all its water vapour in the invisible state and when it reaches its *dew-point* some of its water vapour condenses on the cold ground as dew. If it is particularly dry, it may not reach its dew-point until the temperature has fallen below freezing-point, in which case hoar-frost instead of dew is deposited.

Of greater importance is the fact that water vapour also condenses in the form of tiny droplets on many small particles floating in the air to give us fog. Such particles we call *condensation nuclei*; those which seem particularly likely to help fog formation include salt spray, dust, soot, and most of the large variety of electrically charged chemical compounds found in great numbers in smoke produced by some form of burning in air and poured forth from the chimneys of factories and industrial plants, and of course of our own homes. This then is the reason why the fog is so thick and unhealthy in our large towns and industrial areas; it explains too why we have a special name for this obnoxious smoke fog—*smog*. If only we could prevent the pollution of the atmosphere by our chimneys our fogs would be no thicker and as free of harmful chest irritants as the fog we breathe in the open countryside or at sea.

Whether the fog disperses or not depends on what happens to the temperature inversion. As the sun rises, the earth becomes a little warmer, and bubbles of surface air

begin to lift. These bubbles will be unable to continue to lift if the air above is warmer and lighter than they are themselves. The best we can expect is for the sun to heat the earth sufficiently to destroy the inversion. Then the surface air can escape and share the dust and soot particles, on which its water vapour has condensed, with the upper atmosphere; we see the fog banks lift to form low stratus cloud and, as the temperature rises still more, the cloud droplets evaporate once more into water vapour to reveal blue sky. This happens in summer.

In winter, however, the overhead sun is far to the south, and the heat we receive from it even at midday is very small. Consequently, even though the surface temperature increases during the day, the inversion may persist all day at a few hundred feet above the earth acting as a 'lid' to convection. During the day, then, in industrial areas the fog may thin out a little and even lift to low cloud but will fall and thicken again as the sun goes down. All the soot and dirt particles are therefore trapped in the narrow surface layer. If there is a steady though light surface wind, as in a ridge of high pressure, these particles are at least blown away horizontally, and we share our thinning fog with the neighbouring countryside. At the centre of an anticyclone, however, there is no horizontal drift of wind and, if the centre persists over us, we add today's soot to that which was trapped yesterday, and very serious smog can result. Perhaps we have all experienced difficulty in getting smoke to go up our chimney in calm anticyclonic conditions.

We can blame the smog then on the sun, for if the sun were more powerful in winter we should not experience anticyclonic gloom. But the remedy is surely in our own hands; we must cut down smoke pollution of our atmosphere by industrial and domestic chimneys.

Fortunately our mid-November anticyclone on this particular occasion was very short-lived; the Atlantic air-

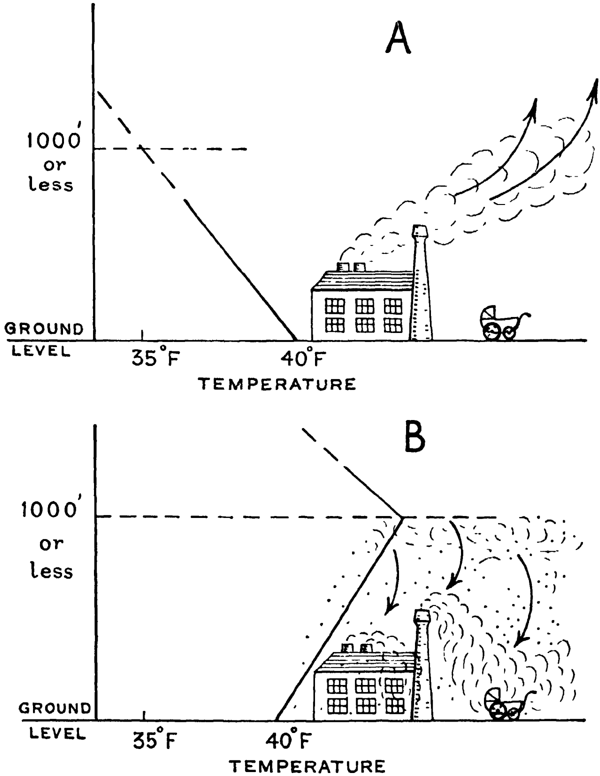


Fig. 27

A. Normal temperature decreases with height. Smoke rises and escapes to higher altitudes

B. 'Inversion conditions. Temperature increases with height. Smoke is 'damped' down by the lighter air above. If the day is cold and damp 'smog' forms on soot particles and thickens.

stream pushed back the Continental ridge to some purpose until the end of December and the weather, though changeable was quite mild.

This particular December indeed gave us an example of the need to be ever on the alert for the unexpected when forecasting our weather. A depression developed and remained stationary off the coast of north-west Africa with the result that a southerly wind carried a *Tropical-Continental* air mass across Spain and France into the British Isles. Now T-C is an unusual visitor, particularly in winter, but the several days of mild May-like weather were very welcome to us. Winter sports enthusiasts, however, would have preferred the extremely cold weather occurring at the same time on the Continent, east of Germany. These enthusiasts were not alone in asking, 'When do we get snow?'—so perhaps we had better answer that question next!

CHAPTER 11 *SNOW OR RAIN?*

ANY of the three processes already described which give us rain or showers will give us snow instead if the temperature of the air through which the precipitation is falling is low enough. So to get snow we must have either one air mass being lifted over another as at a 'front', or an unstable, fairly deep, air-mass like P-m lifted forcibly from the warmer surface by convection or forced upwards over higher ground; in addition the freezing level of 32° F. must be either at or near the surface.

The mild December of 1953 was followed by a renewal of the 'Battle of Britain' between the Continental High and the Atlantic airstreams—the struggle going mainly to the Atlantic side for the first three weeks of January 1954,

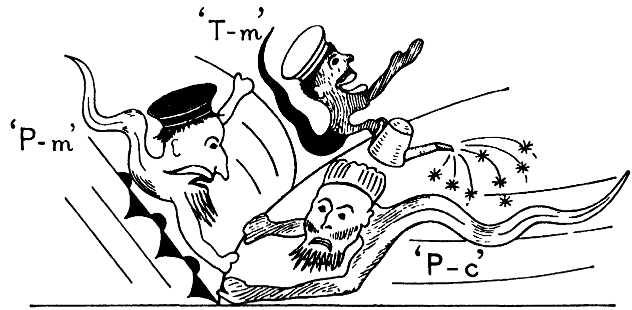


Fig. 28.—'Battle of Britain'

'P-c' holds up the advance of 'P-m' but occluded 'T-m' makes his presence felt!

which proved, apart from two or three days, fairly mild. Then the Continent 'absorbed' into its circulation an anticyclone which moved from Iceland slowly into Scandinavia and remained there for the rest of the month. Southerly winds over the British Isles changed very slightly to south-easterly but enough to bring us in the P-c airstream; temperatures fell rapidly and frost was widespread over England. This was the period when we heard it often said, 'It's cold enough for snow'. But we have seen that this is only half the story. It was cold enough, but the great lifting required for cloud development is impossible in a ridge of high pressure. The snow would come if the Atlantic fronts could push into the cold Continental air. This they did on 25th January. Let us look at the chart for 6 a.m. on the 26th (fig. 29).

Notice that the occlusion which pushed in from the Atlantic yesterday, reaching a line from north-west Scotland to the north-west tip of Brittany, has made no further progress in the north against the Scandinavian High but is pushing into France in the south, and a centre of low pressure has developed in the English Channel. Thus the whole of eastern England and Scotland is in the cold Continental airstream, with inland temperatures at, or a little below, freezing-point. The tongue of warm air trapped above the occlusion is lifting above this wedge of cold air, giving the frontal cloud belt, but now, when the cloud droplets freeze to ice and fall out of the cloud, they do not melt to give rain this time for it is too cold; instead more water vapour condenses on each in the form of delicate ice-crystals which gradually increase in size and fall to earth as snow-flakes. In general the moister the air the bigger the flakes if the surface temperatures are at or a little above freezing. Higher temperatures melt the flakes, the snow turning to sleet. Temperatures well below freezing give drier more powdery snow. Ice crystals are well worth looking at

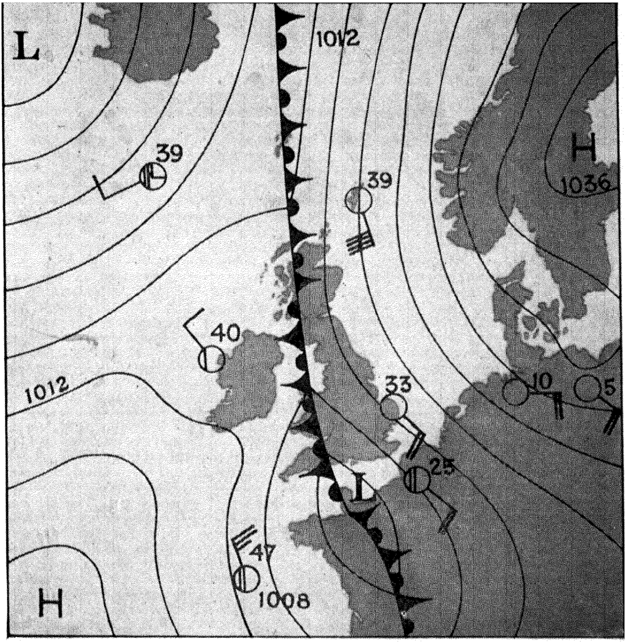


Fig. 29.—6 a.m. 26th January, 1954. Snow in S England. Winter's 'Battle of Britain' is in full swing with the Continent holding back the Atlantic onslaught for the moment. Note the temperature differences in the two air-masses.

under a microscope or with a magnifying glass for their symmetry, variety, and beauty.

The occlusion in the north gave only a narrow belt of light rain, snow, or sleet, but near the small depression centre considerable snow fell inland in most western districts of England and in southern England, though it did not reach the south-east. The depression centre skirted the edge of the Continental High, moving quickly across France, and by next morning was in the Mediterranean.

Meanwhile, in Great Britain the Continental ridge had pushed west again bringing cold dry east to south-easterlies almost as far west as Central Ireland, where it halted as if waiting for the next assault. Western and southern England, with considerable snow cover, northern and eastern England and Scotland, fairly snow-free but frost-bound, waited too. The next depression too was diverted into the Mediterranean, and the P-c air-mass consolidated its position by sending a strong easterly stream over the country, and the frost intensified. Then the Atlantic attacked to the north of the ridge, squeezing it southwards over England and followed it with frontal systems across Scotland and into the Baltic; then a direct attack to bring the whole of the country into milder Atlantic air and finally to thaw the north (which had escaped with less snow finally than the south but had found it more persistent).

Thus sped February's weather and everyone was talking of and hoping for an early Spring. But the Atlantic rather 'overdid' it and illustrated another 'snow situation' and introduced us to another air-mass, *Arctic-maritime*, a near relative to P-m, but even more vigorous.

Let us look at one more wintry chart, that for 6 a.m. of 1st March. The Atlantic Low has pushed into north-west Denmark a couple of days previously, and the Continental High apparently retreated far into Russia; but winter was not over for us yet. A northerly airstream burst across the British Isles to the west of the stationary Low, an airstream which had literally come from the Spitzbergen area, true 'Arctic-maritime' in fact. Just as P-m air gives us frequent showers as it moves south over the warmer surface, A-m gives showers of snow, more frequent in the afternoon and in the north, dying out well inland to give a cloudless bitterly cold night. Over the Atlantic meanwhile an anticyclone has built up, so that the depression track is confined to the zone Iceland south-eastwards to south-west England.

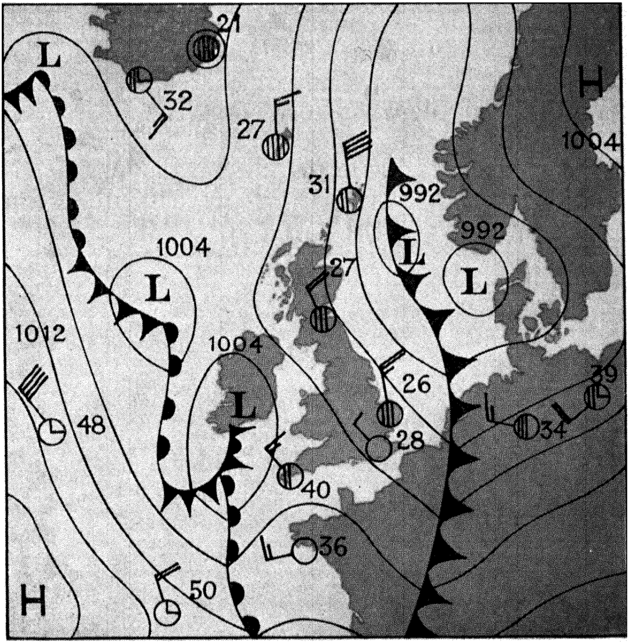


Fig. 30.—6 a.m. 1st March, 1954. 'Snow showers, frequent in the north and east of Britain.' Arctic-maritime air ('A-m') covers the British Isles. Compare here the temperature in this air-mass with those in the Continental and in the Atlantic air-masses.

Prospects then are of snow showers to the east, and be ready for more continuous snow if and when the Atlantic depressions move in. But already the sun feels much warmer than it did a few weeks ago, and almost succeeds in melting the snow before the next shower arrives, so that this is a much more hopeful snow chart than those due to the Atlantic-Continental struggle earlier. In any case the next direct assault by an Atlantic depression is likely to be fairly fast-moving, replacing the earlier Low which is now filling

up, so that the fronts are not likely to become stationary over one unfortunate part of the country this time. But A-m is pretty persistent and may shoot south again in the rear of the next depression, so we must be on our guard against renewed wintry conditions.

We have followed the serial story of the weather together for nearly four months now. Are the weather maps still meaningless 'doodles' to you? I hope not sincerely. You have met all the main air masses and studied their winter antics; their behaviour in summer is not usually quite so complicated.

CHAPTER 12 *APOLOGY FOR A SUMMER*

'. . . their behaviour in summer is not usually quite so complicated'. I wrote that early one March. How was I to know that the summer of 1954 was to turn out to be the worst for over fifty years? Certainly not from the weather map, a study of which we have seen enables us usually to get a fair idea of tomorrow's weather and, very occasionally, to give a general outlook for the next few days. Forecasting for longer periods than this, the so-called 'long-range forecasting' is still in its infancy.

The problem has been tackled in another way, too, by carefully examining weather records over a large number of years in the hope of finding useful cycles or long-term trends. We know now too that certain times of the year are more than likely to give a certain type of weather. But, for instance, though we know that on the *average* the middle of July and the first half of September are sunny periods, there is no certainty that this will be the case in any particular year.

Nor does it seem to be true necessarily that a bad summer will follow a mild winter. Nor does there seem to be any good reason to think, as did a good many people, that the explosion of a few hydrogen-bombs in remote parts of the world gave us our bad summer! Powerful though this terrible bomb may be, it would require a very large number of such bombs to set in motion the many million tons of air we know to be moved in even quite a small depression. If, however, such bombs were used to change the shape of a huge land mass or to break up large areas of the polar ice-cap, causing many more icebergs to float

southwards, then the consequent though slight change in surface temperatures might 'trigger-off' marked changes in weather over wide areas.

This would not be the first time that man has changed his weather. He has caused deserts by felling trees and over-cropping the ground thus won; he has herded into big cities and caused artificial smog by polluting the air. But he did no more of this in 1954 than in the preceding years so cannot be blamed for his bad summer.

A bad summer, however, did not mean that the forecasts were difficult to follow or that the daily serial of weather maps was any the less interesting. On the contrary, if you had followed the charts that particular summer after reading the previous chapters on the behaviour of depressions you would have had more forecasting experience than is usually gained in half a dozen other summers, experience, that is, of rapidly changing fronts and air masses. You would also have realized how unenviable is the task of the T.V. Weather Men.

One of these forecasters is expected to tell everyone, all over the country, not only what conditions have been like today but also what to expect tomorrow, and all in less than five minutes too! Since he appears personally in our homes we are inclined to forget that he is not responsible for the forecast but is the mouthpiece of the whole weather organization, particularly of the Central Forecast Office at Dunstable. Thus we hear that Mr. X's forecasts are more reliable than Mr. Y's, when it was merely Mr. Y's misfortune to be on duty when the official forecast went particularly astray. More amusing, too, is the tendency for many people to blame the Weather Man for the weather and he, poor fellow, being human, is only too conscious of this and foolishly adds to the impression by including an apology in his forecast such as, 'Well, there it is, I only wish it could be better'. This does not include Mr. W, however,

Fig. 31.—'. . . a clearance has already reached Anglesey'
Photograph by Anthony Wade, Penmaenmawr

who belligerently disclaims all responsibility for the weather and occasionally for the forecast.

If we are to make the best use of the weather forecast, then it is necessary to know of all these difficulties and limitations. The weather forecaster should be regarded as weather adviser. He explains briefly the present situation and, though knowing often that there is more than one possibility of development, he has frequently only time to advise us of the most likely happening for tomorrow. It is up to us to learn enough about the weather to modify that advice as and when necessary.

To give an extreme example, a party on holiday in North Wales heard Mr. Z forecast that a slow-moving occlusion would be situated over the mountains on the morrow giving hill fog and drizzle for most of the day, and a planned excursion to climb Snowdon was tentatively abandoned. The following morning, though the distant hills were covered in cloud, a clearance had already reached

the coast and a fresh north-westerly wind gave every indication that Mr. Z's occlusion had moved southwards at a much faster rate than had been anticipated. Even without such weather knowledge, the 7.55 a.m. weather bulletin on sound radio forecast that the front was moving south and was expected to clear all Wales by noon. Nevertheless, for one member of the party, there was the cloud on the hills just as forecast, and Mr. Z said that it would remain all day—so that member missed the only good day of his holidays for mountaineering. Which revealed a touching belief in the cherubic Mr. Z but a complete misunderstanding of the purpose of the weather map!

Worse still are the people who set off in the teeth of a forecasted gale, in the sure belief that the Met. men are always wrong, and believing rather the local postman's forecast of an improvement—probably derived from a forecast for the Iceland Sea Area mistakenly overheard during a hurried breakfast!

But let us return to the weather map and discuss the hopes and disappointments of some subsequent springs and summers in the certain knowledge that similar situations will arise again in future years.

CHAPTER 13 *SPRING AND SUMMER PAST—AND FUTURE?*

THE weather map we all hope to see to give us warm and sunny weather in spring and summer is one dominated by the 'Azores anticyclone'. The Azores, of course, are a group of islands some 600 miles west of the coast of Portugal and give their name to the more or less permanent belt of high pressure which exists in their neighbourhood. This belt tends to move northwards with the overhead sun and in spring or summer sends out periodically a ridge of high pressure far northwards over the North Atlantic, or north-eastwards extending to the British Isles and neighbouring Continent. This ridge itself may develop a separate centre of high pressure and become slow moving.

Our map would look something like the 'smog' map of fig. 26 but with the anticyclone extending much farther north and connected south-westwards to the main Azores High instead of to the Continent. The surface air would originally be warm moist T-m, giving sea-fog banks as it moved over the colder sea, but instead of smog near large towns the sun would be strong enough inland to disperse the mist soon after dawn to give a warm sunny day. Little or no cloud would be expected, since, as we have learned, the upper air in an anticyclone is gently subsiding and warming. If this situation persists, the surface air too eventually dries out.

To complete this ideal picture, the depressions move on a track far to the north around the edge of the High and the few fronts which succeed in penetrating the anticyclone cause it to retreat only temporarily and prove to be mainly

cloud belts giving little or no rain. After a fortnight of this we should probably declare a 'drought' and even ask for rain.

In forecasting tomorrow's weather we do well to look at the nearby depressions and to judge the likely movements of their associated fronts. To attempt to look farther ahead we should also watch the drift of the slower-moving anticyclones which, to go back to our stream analogy, stand out like pebbly mounds between which the whirlpool-like depressions swirl and which are occasionally washed away or caused to re-form elsewhere. For this purpose it is better to look at the 'Atlantic Chart' which covers the whole of the North Atlantic, giving a glimpse of Northern Canada and Greenland and much of Western Europe. The actual 6 a.m. chart for this area is shown on B.B.C. T.V. each evening and the forecast chart for midday, also for this area, is printed now in several daily newspapers.

It can be fascinating, sometimes morbidly so, to watch the slow movement of anticyclones and to see unfolding the general, if not particular, pattern of weather for several days or even for a couple of weeks ahead. This we can do if we realize that the anticyclones often appear to steer around their edges the unsettled weather of a succession of depressions. It is this positioning of anticyclones relative to the British Isles which decides the nature of our weather, particularly in spring and summer. The effect of the Siberian High in winter has been discussed previously.

In April 1954, for example, we did see an anticyclone on our weather map, but it was not the Azores anticyclone. Since its air was of northerly origin at surface, a type of P-m in fact, we can call it, for the purpose of this account, the Northern High. This anticyclone drifted across England into the northern North Sea and back into the Atlantic by way of north Scotland, and April as a result was on the

whole a month of quiet, dry and sunny, though cool, weather.

From then on it is a fair approximation to say that the Northern High, in various disguises, appeared and disappeared in Greenland or to the north of Scotland or in northern Scandinavia and, often in conjunction with the Azores High in mid-north Atlantic, appeared to steer a succession of depressions across the British Isles and well into Europe for nearly the whole of the next four months.

Yet at no time was fine weather far away, and wide differences were reported over the country, which made the weather maps so exasperatingly interesting to follow day by day. On 22nd June, for example, it seemed that at last the Azores anticyclone showed signs of intensifying and extending a ridge of high pressure north-eastwards over the British Isles, and on Wednesday the 23rd in an optimistic 'outlook' a fine Wimbledon Friday was forecast.

How wrong can an 'outlook' be? A shallow depression south of south-east Greenland trailing a 'wave' depression on its cold front over far-away Labrador at noon on Wednesday (see fig. 32*a*) received a burst of very cold 'Arctic-maritime' air as it reached Iceland, and deepened considerably. By Friday noon, as shown in fig. 32*b*, the 'wave' depression marked M on the charts had crossed the Atlantic at something over seventy miles per hour to give a broad belt of rain over the Midlands and the south-east of England, and so much for Wimbledon tennis!

So much too for any immediate hopes of a settled summery spell; the following day saw the A-m air penetrate the whole country and Sunday's Atlantic chart (fig. 32*c*) showed the Azores High firmly established in mid-Atlantic and linked with the Northern High. There it loitered, like a sulky traffic policeman, directing, as if with evil intent, a continual stream of depressions across the British Isles from between the north and north-west almost for the whole of

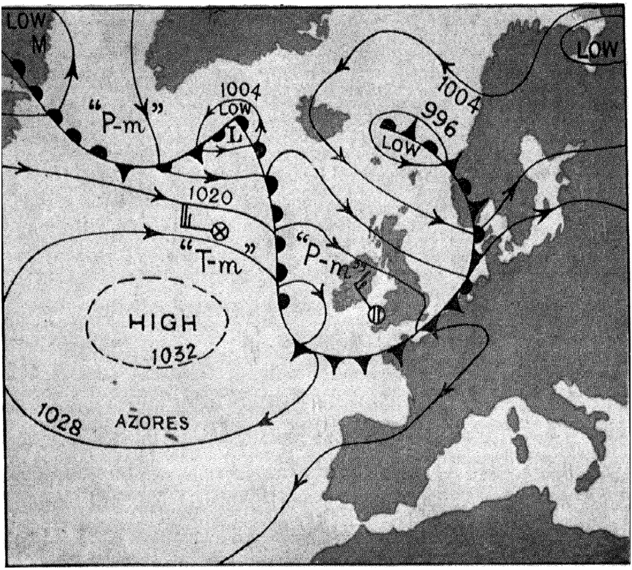


Fig. 32*a.*—*Weather Map for noon, Wednesday* 23rd *June*, 1954

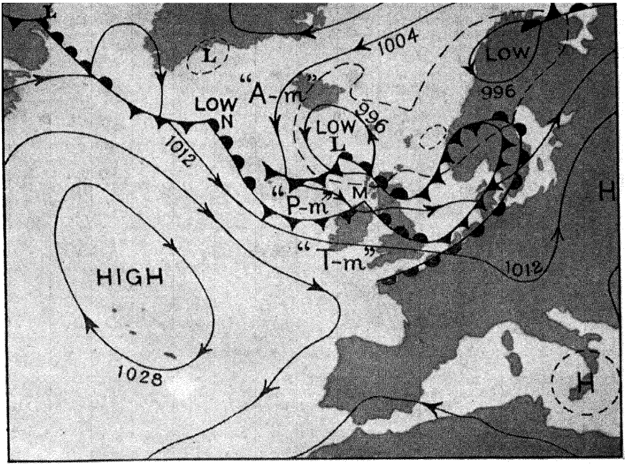


Fig. 32b.—Weather Map for noon, Friday 25th June, 1954

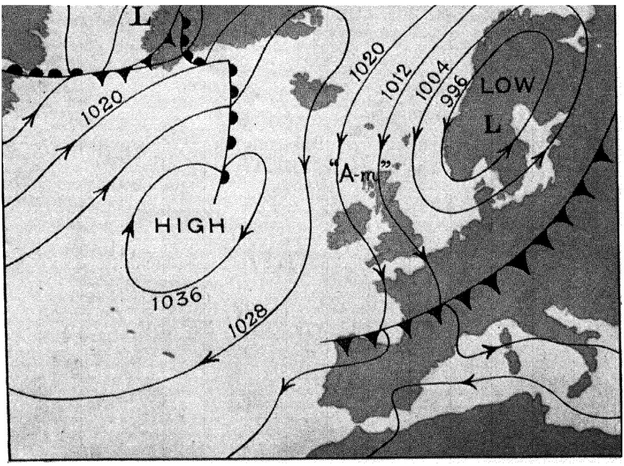


Fig. 32c.—Weather Map for noon, Sunday 27th June, 1954

the next two months. Never for very long were we out of air of northerly origin, usually some form of Polar-maritime, P-m. Now P-m we know to be a versatile character from our study of winter weather maps (Chap. 9). His 'April shower' antics are even more difficult to anticipate in summer when surface temperatures are so much higher than those aloft.

This to some extent explains the greatly differing stories of holiday weather we hear from friends on their return. 'Yes,' they say, 'it wasn't too bad. It didn't rain at all on two days, except in the afternoon, and it was quite warm once or twice, sheltered from the wind, of course, behind the breakwater!' Now we, who have been following the weather map each day, know that on no day during the last fortnight has a temperature of over 65° F. been recorded, and we begin to wonder what is meant by feeling 'quite warm'. The thermometer it appears is no guide on its own.

We feel warm when, in trying to keep our blood temperature to its normal 98·4° F., we find difficulty in giving up body heat to our surroundings. This we normally do by perspiring, and it is the evaporation of this perspiration which cools us, since evaporation is always accompanied by cooling.

The rate of evaporation depends on several factors. If we are in great haste, or ill-mannered enough, we cool our tea by pouring it in a saucer and blowing on it. This illustrates two of the factors; we can increase the surface area exposed to the air and increase the speed of the air over that surface to increase evaporation. Even this would be of no use if the air was already saturated with water vapour, say as in a steamy Turkish Bath atmosphere, but conversely the drier the air the greater will be the rate of evaporation of water vapour into it and the greater the rate of cooling.

Our friend huddled behind the breakwater with his face

only exposed to the air and protected from the wind may feel 'quite warm', but if he was to sit in his bathing trunks on the other side of the breakwater he would feel 'quite cold', yet the temperature of the air mass would be the same. If the P-m air mass was suddenly changed to tropical-maritime, T-m, and even if we assume that the wind strength and temperature remained the same, the sudden increase in humidity would make him feel considerably warmer since the rate of evaporation of water vapour from his skin would have decreased.

Our feeling of well-being does not, however, depend merely on these factors affecting evaporation of perspiration; it depends too on how much of the sun we see, and feel. Most of us, without knowing why, would cheerfully exchange a hot, muggy, dull day for a somewhat cooler but sunny one. The sun, in addition to visible light rays and invisible but heating infra-red rays, radiates invisible ultra-violet rays. These ultra-violet rays act as a tonic to our systems; they give our skins a healthy sun tan, but too much ultra-violet will give nasty sunburn and prove injurious to the eyes. Ultra-violet rays are almost completely absorbed by cloud layers and severely weakened by a very humid air mass or by a smoky industrial atmosphere; conversely they are reflected back at us by some surfaces like the open sea or snow layers, so that we get an extra dose of sun tan near the sea or in the rarefied clean atmosphere on higher ground, particularly if it is snow-covered. Thus in the same conditions of temperature and humidity we can feel the heat oppressive in the city or exhilarating in the nearby country or by the sea.

All this gives further reasons for our sense of frustration at a summer of predominating P-m air. P-m, drier though cooler than T-m, when well-behaved gives us bright sunshine and lets in the ultra-violet rays; we are getting suntanned even though maybe wind-swept; this is ideal for

active exercise. Then along comes the shower belt with its many-thousand-foot-thick cumulonimbus cutting off the sunlight, the temperature drops several degrees, the gusty wind adds to our discomfiture and summer seems as far away as ever!

The brief visits of T-m help us little, preceded as they are by increasing cloudiness and frontal rain. The rain is followed by a very humid T-m which, even if it does not give drizzle, gives low stratus cloud and, although it is warm, it is more oppressive than exhilarating. Just one determined push north-eastwards by the Azores High would cause the thin cloud to break and the temperature to soar; in the moister air we could sun-tan at a more leisurely pace. Sunshine and T-m are just the conditions for lazing or for taking mild exercise. But no, P-m is already pushing down again, here comes another cold front or occlusion rain belt and we are back in P-m again!

If the fast-moving depression is a headache for the forecaster, so also is the slow-moving one and arithmetically for the same reason; an error of 10 m.p.h. is easily made when the depression travels at 60 m.p.h., it is also easily made when the depression slows up as it approaches the country at 10 m.p.h. to become stationary. In forty-eight hours this error can give almost an error of 500 miles in the placing of a weather belt. An unusually prolonged example of a slow-moving depression occurred in August, 1954.

About the middle of August the Azores and Northern Highs merged to the west of Ireland and high pressure extended from the Azores to the north-west of Scotland and thence to northern Norway. For the first time since mid-June the stream of Atlantic depressions seemed to have been cut off; a shallow depression trapped over Holland it was thought would surely fill up as the ridge moved eastwards into the British Isles. Not a little bit of it! This Low persisted in the southern North Sea from the 16th to the

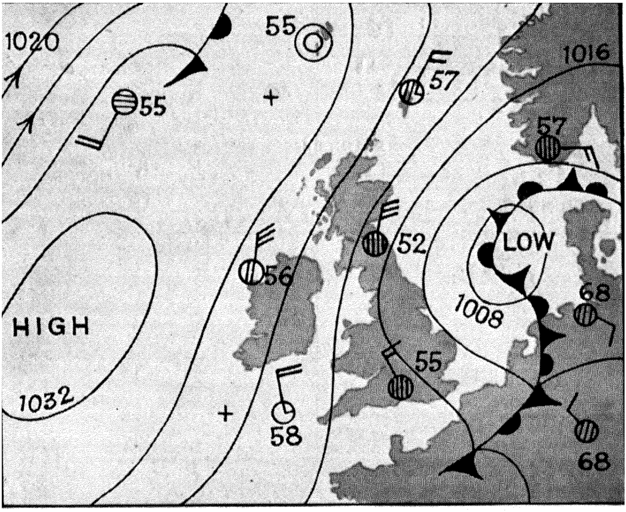


Fig. 33.—*Noon, 19th August,* 1954, *during the 'Midland Monsoon'. Note the northerly winds over the whole country. This was London's coldest 19th August since* 1871.

25th and, receiving colder bursts of air from the Baltic to add to its miscellaneous collection of the remains of old occlusions, once or twice it deepened and 'came back' at us. As a result, for the most of ten days the eastern half of England suffered cold damp winds of North Sea or even of Baltic origin with overcast skies and several days of continuous rain.

On the days when the cloud broke, sporadic thunderstorms broke out too over the heated ground, giving torrential rains in widely scattered areas; newspaper reference to the 'Midland Monsoon' became frequent and the name was not unmerited. Meanwhile in the west, particularly in the Hebrides and in Cornwall, though the winds were northerly, the weather was drier than average

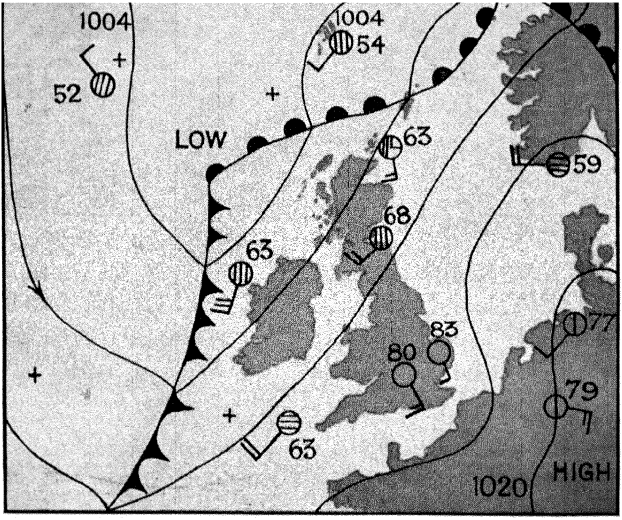


Fig. 34.—*Noon, Wednesday* 1*st September*, 1954

'*Summer* 1954 *fell on a Wednesday!*'

and generally anticyclonic. With such fine weather exasperatingly near, a forecaster, though giving a pessimistic forecast for the morrow, is sorely tempted to promise better things to come on the following day. When, day after day, the weather shows no sign of improvement, the general public is apt to become justifiably abusive and even derisive at the 'experts'. We who follow the daily charts, though equally exasperated at our weather, are more able to sympathize with the forecasters.

Fig. 33 is the midday chart for Thursday, 19th August, and is typical of many days during this period. This was the coldest 19th August in London since 1871; the day temperature did not exceed 55° F.

However on 26th August the ridge of high pressure did

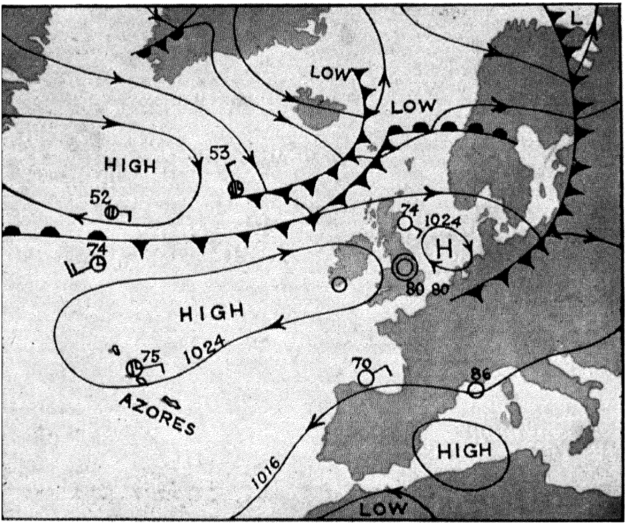


Fig. 35.—'Summer 1955 lasted three months'

This map for noon 16th July is a typical one for this ideal period. Temperatures are above 80 degrees F. generally inland though lower in sea fog patches on the East Coast.

at last push eastwards. To justify, at last, an ancient music-hall joke, summer in 1954 actually fell on a Wednesday, the 1st of September. For six whole hours on that day the entire British Isles was free of fronts and in southerly T-m air; London Airport recorded a maximum temperature of 83° F., beaten only by Mildenhall's 85° F. For the record this remarkable situation is illustrated by fig. 34.

How different the summer of 1955 turned out to be in comparison with the one-day summer of 1954! And yet it appeared to be following the same pattern as 1954, with a very changeable cool cloudy May and June after a dry April. Again almost to the same day towards the end of June a change of type appeared possible; this time, how-

ever, the pressure did rise over the British Isles and a high-pressure system, once established, extended from the Azores across the British Isles to Scandinavia for almost the whole of July, and warm dry sunny weather in the main persisted throughout most of July, August, and September.

Fig. 35 shows the chart for noon of 16th July and is a typical one for this ideal period. Notice particularly, in addition to the extended Azores High, the build-up of high pressure over the North Sea and over the north Atlantic, which subsequently extended as a separate system of high pressure over Scandinavia. The joint 'blocking' action of the well-established Azores and Northern anticyclones seems necessary to assure us of a settled summery spell. With the Azores anticyclone alone the east of the British Isles is open to a northerly airstream; with the Northern High alone the north-west of the country at least, if not the whole of the west, is open to invasion by Atlantic depressions.

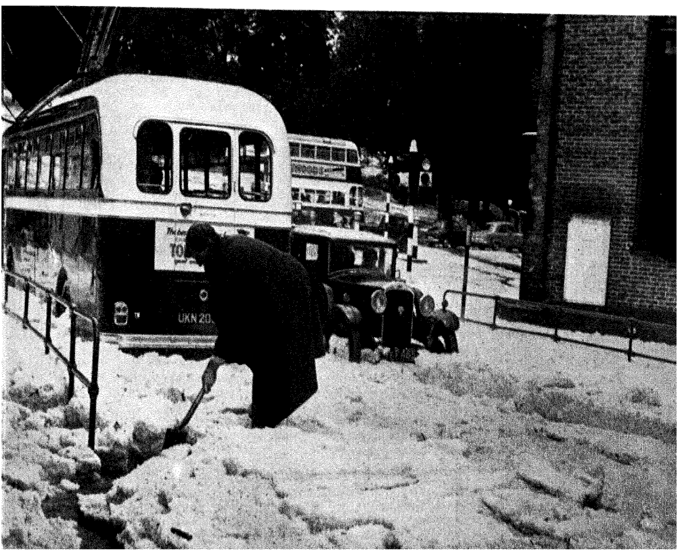
Summer 1956 proved to be an even more exasperating one than that of 1954. After a very dry and anticyclonic May, the two major anticyclones again, as in 1954, failed to develop into 'blocking' systems; instead, from June to August a continual stream of unstable air masses flowed across the British Isles. It must have been a very similar summer in 1594 which Shakespeare is thought to have had in mind when, in *A Midsummer-Night's Dream*, Act II, Scene I, he lets Titania say:

> . . . Therefore the winds, piping to us in vain
> As in revenge, have suck'd up from the sea
> Contagious fogs, which falling on the land,
> Have every pelting river made so proud
> That they have overborne their continents:
> The ox hath therefore stretch'd his yoke in vain,
> The ploughman lost his sweat; and the green corn
> Hath rotted ere his youth attain a beard:

> The fold stands empty in the drowned field
> And crows are fatted with the murrain flock:
> The nine men's morris is filled up with mud.
>
> . . . .
>
> And thorough this distemperature we see
> The seasons alter; hoary headed frosts
> Fall in the fresh lap of the crimson rose,
>
> . . . .
>
> The spring, the summer,
> The chiding autumn, angry winter, change
> Their wonted liveries, and the mazed world,
> By their increase, knows not which is which.

It did apparently snow in Kent on August Bank Holiday Monday; photographs appeared in the Press of snow removal taking place in Tunbridge Wells! What actually

Fig. 36.—'Snow on August Bank Holiday Monday'
This photograph was taken at Tunbridge Wells towards noon on 6th August, 1956
Kent & Sussex Courier



happened was that in a very heavy thundery outbreak considerable hail fell at many places in south-eastern England; this hail, which was mainly of the 'soft' variety, drifted locally 'to a depth of four to five feet at the foot of Mount Pleasant by the station and in Nevill Street in Tunbridge Wells'. The air temperature nevertheless was about 25° F. above freezing-point; the noon temperature at London Airport was 55° F.

Considerable thundery outbreaks and very highly localized torrential rain were in fact a marked feature of this summer of 1956. Is it possible to forecast such outbreaks with precision? The answer is yes—and no! Yes, the possibility of a thundery Bank Holiday could be foreseen some three days previously, but no, not precisely in Nevill Street, Tunbridge Wells, nor even necessarily in Kent rather than elsewhere in Southern England!

Fig. 37*a* shows the Atlantic chart for noon, Friday 3rd August. Our two anticyclones are stationed as is usual in a bad summer in mid-Atlantic, directing a stream of northerly air, here it is of 'Arctic-maritime' air, across Britain and deep into France. The small Low between Iceland and north Scotland is a common phenomenon in this airstream. This 'polar Low' can be regarded as a large pool of very cold dense air and is being swept southwards into much warmer surroundings. Great bubbles of this air are therefore likely to lift over the heated ground and to develop into thundery towering cumulonimbus clouds as already explained.

The farther south this northerly air penetrates the greater is the difference in temperature between the heated surface and the cold air mass and the more violent the thundery outbreaks. The progress southwards of this polar Low is indicated in fig. 37*b*. By Bank Holiday Monday, three days later, though the supply of A-m had been cut off in the north, the original polar Low had swirled into northern

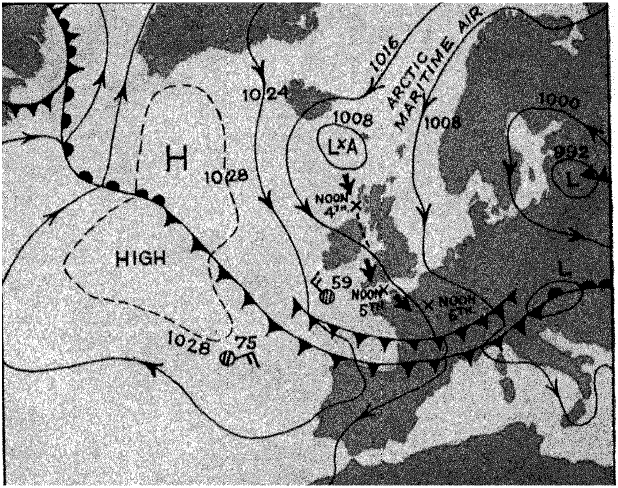


Fig. 37a.—Noon, Friday 3rd August, 1956

A thundery Bank Holiday is promised for Britain. The position of Low 'A' subsequently at noon on the 4th 5th, and 6th, has been added to this map

France where it sheltered like a stagnant pool. The thundery outbreaks which broke out in this unstable air as the sun rose higher in the sky during the morning affected south-eastern England, too, to give Tunbridge Wells among other places its snow-like 'soft' hail and to give Flanders, later, torrential afternoon rains.

To see just one more example of this summer's 'change of wonted liverie' caused by another air-mass moving very far from its accustomed home let us look at fig. 38. The weather appeared to relent in September, and the Northern High drifted from mid-Atlantic to Scandinavia and brought, if not summer, then the quiet sunshine of autumn, interrupted only occasionally by wilder Atlantic

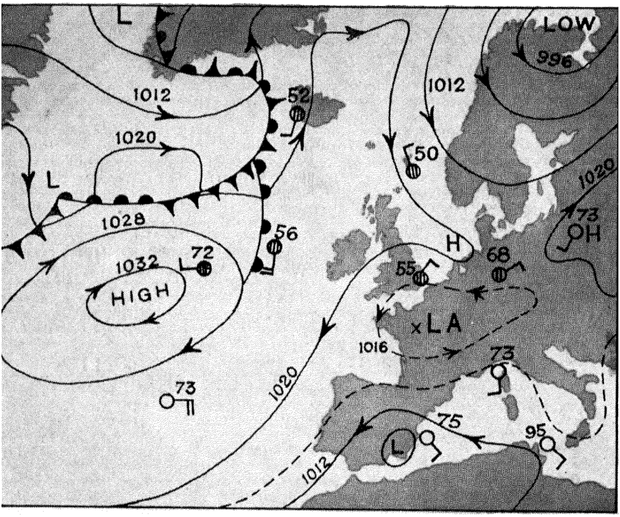


Fig. 37b.—Noon, Monday 6th August, 1956

'Snow' in Kent!—due to Polar Low 'A' over Northern France giving rise to violent thundery outbreaks

weather. The complete retreat of the Azores anticyclone, however, and its replacement by an almost stationary depression to the south-west of the British Isles, brought southerly winds which for several days brought 'tropical-continental' air across the Mediterranean and France to stream northwards over the British Isles. Away from the frontal areas in the south-west temperatures rose to the mid-seventies, and the forecast was 'fine and warm apart from sea fog patches and low cloud from the Wash to Shetland'.

Once again, to the uncooperative, the forecaster may be as much as 100 per cent wrong in certain localities for these are *haar* conditions. On eastern coasts the day may be

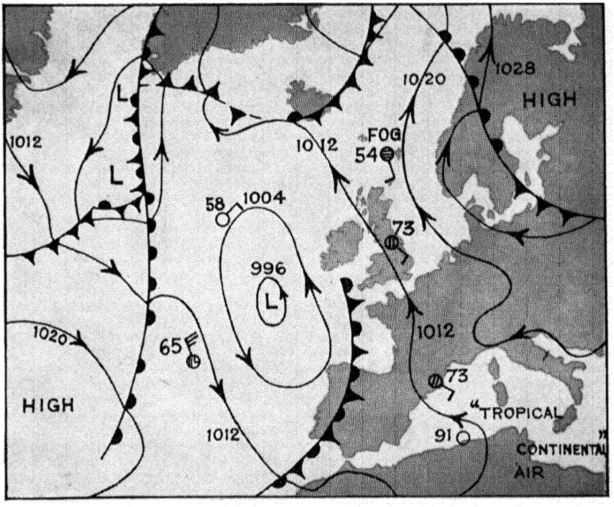


Fig. 38.—Noon, Sunday 23rd September, 1956

'Tropical-continental' air is another unusual but welcome visitor bringing a belated summery spell to all but the 'haar' areas on the eastern coasts

warm and sunny, a little hazy perhaps; then, on the highest hill slopes, a little plume of mist or cloud is seen. Within the hour the whole scene may be blotted out by banks of sea fog or thin wispy low stratus cloud. This is the *haar*. It occurs more generally in spring or in autumn when moist air, having a long south to south-easterly 'fetch', flows northwards over the North Sea. The air is thus flowing over progressively colder water surfaces, and eventually it is cooled at sea-level to its dew-point, and the excess moisture it carries condenses out as sea fog. This fog may only be a few hundred feet thick and the sky perfectly clear above. As the fog drifts inland the heated land may be warm enough to disperse it again to give cloudless conditions—or

one valley may clear yet another retains its fog. A slight change of wind during the night may take the fog far inland, or the earth cooling under cloudless skies by radiation may cause it to form in any case by dawn. Whether the day becomes fine and warm here by noon, by 2 p.m., or even at all, is usually the matter of a degree or two of temperature either way—and can possibly be judged better by local knowledge or intuition than by listening to a general area forecast.

The 'North Sea stratus' which an easterly wind off the North Sea brings often to eastern coasts and which may penetrate far inland under certain conditions is a similar phenomenon. So, too, in the west a moist south-westerly airstream may bring to some coastlines sea fog for many hours, yet sheltered coves or places to leeward of hills may escape the fog altogether and have brilliant weather.

Certain holiday resorts, quite naturally, resent being included in a general forecast outlook area of mist or low cloud when locally the mists may clear. Local forecasters claiming to forecast the weather without any help from official weather maps but instead reading the 'signs' in the behaviour of birds and insects have, in one place, been engaged in opposition to the Air Ministry forecasters!

How much better to be guided as to large-scale weather trends by the official Weather Men and to modify this advice for your own locality using your own local knowledge and observation. And what a fascinating full-time hobby this weather forecasting can become! Your knowledge be assured is never out-of-date yet never up-to-date. The weather situations here described will never repeat themselves exactly, yet will recur again and again throughout the years in slightly different order and in varying intensity.

We may, for example, at the beginning of any future October be wondering if the middle of the month will

bring us St. Luke's 'little summer' or sharp frosts before the Atlantic depressions come roaring in and we begin to look again for the first signs of the Siberian winter anticyclone pushing challengingly west, for P-c to do battle with P-m and with what remains of T-m above us and so to decide our winter scene. Will it be sunshine or smog—or prolonged snow or a quick thaw? It will be impossible to say, of course. A calendar is of no use to us in predicting our weather, and therein lies the fascination of our climate. Instead, as with all good serials, we must look tomorrow for the next gripping instalment of our 'Weather Map'!

INDEX AND GLOSSARY

adiabatic, cooling by expansion, 24, 52.
warming by compression, 24, 35, 52.

air mass. Where air differing little in temperature and humidity is observed to cover a wide area it is called an 'air mass' and is classified according to its origin, 2.
Arctic-maritime ('A-m'), 60, 62, 69, 80.
Polar-continental ('P-c'), 49-50, 57, 60, 85.
Polar-maritime ('P-m'), 2, 25, 26, 32, 38, 46, 48, 57, 68, 72, 74, 85.
Tropical-continental ('T-c'), 56, 82.
Tropical-maritime ('T-m'), 2, 25, 26, 31, 32, 38, 44, 46, 48, 57, 67, 73, 74, 85.
movement of air masses over a 30-hour period, 38, 40.

Air Ministry, Meteorological Office, Daily Weather Reports, 2, 5.

altocumulus, cloud type, 35.

altostratus, layer type cloud of base height between 8000 and 20,000 ft.; often preceded by thickening and lowering cirrostratus cloud it may be distinguished from cirrostratus in that it eventually obscures the sun or moon and gives no halo. It may then give precipitation and merge with the lower nimbostratus which precedes the arrival of a warm front, 2, fig. 6, 19, 20, 32.

'A-m', see *air-mass, arctic-maritime type.*

anticyclone or high-pressure area or, more simply, 'High'.
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general description, 14.
influence on depression tracks, 44.
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'Continental' type, sometimes known as 'Siberian' in winter, 49-51, 57-62, 85.
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'anticyclonic gloom', 51, 54.

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'Battle of Britain' by air masses, fig. 28, p. 50, 57, 60.

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cirrostratus is a particular type of cirrus cloud taking the form of a thin layer; it does not obscure the sun or moon but gives rise to haloes. It indicates a warmer air mass aloft and so is frequently the advance

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cirrus, high cloud, base 20,000 ft. or above, of delicate and fibrous appearance, 2, fig. 4, p. 18, 31, 32.

clouds are divided for purposes of reporting into three types according to their base height above sea-level. The base of cirrus (or high) cloud is above 20,000 ft., that of altus (or medium) cloud is between 8000 and 20,000 ft. and that of low cloud below 8000 ft. Clouds may also be classified at the same time as layer (or stratus) type or heap (or cumulus) type depending whether they extend over a considerable area horizontally or whether they are broken horizontally but show vertical development. Refer therefore to cirrus, cirrostratus, altostratus, altocumulus, nimbostratus, stratus of the warm-air sector, cumulus and cumulonimbus.

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- we meet a 'cold front', Chap. 6, pages 21-23.

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- of water vapour as dew, 44.
- of water vapour as hoar-frost, 53.

cumulus, or 'heap' cloud, 32, 33, 46.

cumulonimbus is the cloud of thundery showers; it is usually recognizable by being surmounted by an 'anvil' of cirrus which may on occasions extend to a height of over 30,000 ft., 2, 21, fig. 8, p. 22, 32, 33, fig. 12, p. 33, 46, 74, 80.
- diagrammatic cross-section to show interior of cumulonimbus, fig. 13, p. 34.

depression is an area of low pressure. Its centre is called a 'Low' and, for brevity, this word is used often instead of depression itself.
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- fast-moving wave type on a cold front, 69, 74.
- general description, 14.
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- movement around Azores anticyclone, 67.
- movement over a 30-hour period, 36.
- our flight through a 'typical depression', Chap. 5, 16-20.
- 'polar Low' type, 80.
- slow-moving type, 74, 75.

dew formation, 53.

dew-point, 24.
- temperature used in identification of an air mass, 42, 44.

drizzle, precipitation in the form of fine droplets as in a wet fog or in a layer cloud with its base at or near surface. Drizzle is typical of warm sector conditions, 2, 20, 22.

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inversion, see *temperature.*

isobars are lines on a weather map joining places where the pressure, corrected to that at mean sea-level, is the same, 1. 6, 7.
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'P-c', see *air mass, polar-continental type.*
'P-c' is the name, also, of one of the several cartoon characters invented to bring the weather map to life for those of us who instinctively fight shy of such sternly scientific ideas as 'air mass of polar-continental origin'.
in 'Battle of Britain', 50, fig. 28, p. 57, 85.

'P-m', see *air mass, polar-maritime type.*
also as cartoon character (see '*P-c*'), 2, fig. 10, p. 26, fig. 28, p. 57, 85.

polar front, see *fronts.*

pressure, as the weight of air pressing on unit area of the earth's surface, 6, 7.
The International Standard Atmosphere of pressure at mean sea-level is defined as being equivalent to that of a column of mercury 76·0 cm. (or 29·88 in.) long at 0° C. The scientific unit of pressure is the dyne per sq. cm. and to convert the pressure of 76·0 cm. of mercury into these units we must multiply by the density of mercury, 13·59 grams per c.c., and by the acceleration due to gravity, 981 cm. per sec. per sec. This works out to 1,013,216 dynes per sq. cm. Very conveniently then the weather men take as their unit of pressure the *millibar* or one thousandth part of a *bar*; the *bar* they take to be one million dynes per sq. cm. The International Standard Atmosphere is thus 1,013·2 millibars. Isobars on all weather maps in this book are drawn at intervals of either 4 millibars or 8 millibars, and the nearest isobar to standard atmospheric pressure is the 1012-millibar line.
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'T-m', see *air mass, tropical-maritime type.*
also as cartoon character (see '*P-c*'), 2, fig. 10, p. 26, fig. 28, p. 57, 85.

troposphere is the lower part of the atmosphere from the ground to the stratosphere where, on the average, the temperature falls progressively as the distance from the earth increases. At the tropopause, the narrow layer of air separating troposphere from stratosphere, the temperature falls no lower than about —55° C. at a height of 7 to 8 miles over the British Isles and may even increase again as the lower stratosphere is entered. The tropopause then is the upper limit for convection cloud development and for most weather phenomena with the exception of wind, which is measured by balloons traced by radar as they ascend from earth well up into the stratosphere, 24.

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